The Journal of Bone and Joint Surgery*

The Official Publication of the
American Orthopaedic Association
British Orthopaedic Association
American Academy of Orthopaedic Surgeons
Owned and published by the American Orthopaedic Association
*Title registered in United States Patent Office

VOL. XX, No. 1 — *January, 1938* — Old Series VOL. XXXVI, No. 4

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Published quarterly: January, April, July, and October
8 THE FENWAY, BOSTON, MASSACHUSETTS

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Address all Communications to the Editor
THE JOURNAL OF BONE AND JOINT SURGERY
8 The Fenway, Boston, Massachusetts, U. S. A.

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*Lindsay and Howes, Jr. Bone & Joint Surg., 13:491, 1931.
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†Kay and Robinson, Biochem. Jour., 17:28, 1923.
‡Venable et al, Trans. Southern Surg. Assoc. Vol., 49, 1937.

VOL. XX, NO. 1 JANUARY, 1938 Old Series Vol. XXXVI, No. 1

The Journal of
Bone and Joint Surgery

SCOLIOSIS TREATED BY THE WEDGING JACKET

Selection of the Area To Be Fused

BY FELIX L. BUTTE, M.D., NEW YORK, N. Y.
Fellow of the New York Orthopaedic Dispensary and Hospital

This article is not intended as a comprehensive study of scoliosis, but as a study of representative cases in which some of the cardinal principles of jacket correction and spine fusion are briefly analyzed, particularly with reference to the selection of the area to be fused. In the five cases described, the following points are illustrated:

1. The minimum fusion area must include every vertebra in the primary curve. There is an occasional exception to this rule in cases where one vertebra at one or the other end of the primary curve may be omitted from the fusion. The primary curvature is that curve in which the deforming factor is active and for which the other curve or combination of curves is compensatory. Occasionally there are two primary curvatures.

2. The ideal fusion area is one which includes at least the minimum fusion area and in which the end vertebrae are parallel to each other and at right angles to the line joining their centers. In the final result the end vertebrae of such a fusion area will be parallel and transverse to the axis of the trunk.

3. The actual determination of the fusion area—whether or not one or more vertebrae beyond the ends of the primary curvature should be included—is made after correction has been obtained by the wedging jacket.

4. Overcorrection of a curvature and fusion in this position is to be avoided.

5. Provided thereby compensation has been restored, remarkable improvement in clinical and roentgenographic appearance often results when the primary curve has been corrected less than 50 per cent.

6. The value of the pelvic-tilt examination as described by Ferguson is emphasized. The patient sits unassisted with the hands resting on the knees; the pelvis is elevated on the side of the convexity of the lumbar curve as much as can be tolerated without causing the patient to lose balance, usually three or four inches; and a roentgenogram is taken.

FIG. 1

Case 1. Preoperative roentgenogram, with patient standing.

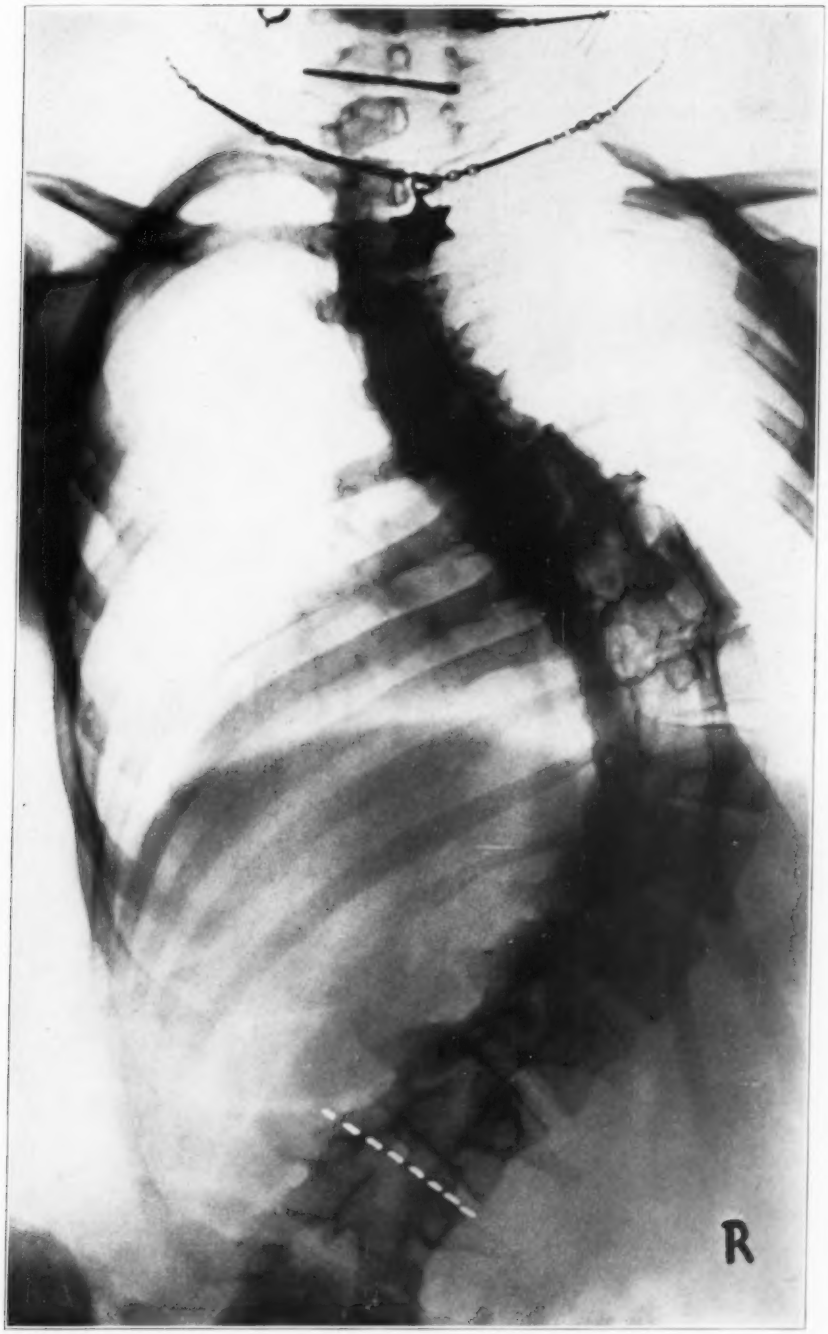

FIG. 2

Case 1. Pelvic-tilt examination. Patient sitting with left side of pelvis elevated.

FIG. 3

Case 1. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

FIG. 4

Case 1. Three years after operation, with patient standing.

Case 1 (Figures 1, 2, 3, and 4)

B. B., female, aged fourteen years, had an "idiopathic" scoliosis, the primary right curve extending from the sixth thoracic to the second lumbar vertebra, with the apex at the tenth thoracic vertebra. She had had jacket correction and spine fusion two years before coming to this Clinic, the fusion having been done from the fifth thoracic vertebra down to and including the eleventh thoracic, but omitting the lower three vertebrae of the primary curve. Figure 1 shows clearly that there had been an increase or recurrence of the deformity at these three joints—eleventh thoracic to second lumbar—and that as the result of this the trunk was shifted to the right side. Fusion appeared solid from the fifth to the eleventh thoracic vertebra.

A pelvic-tilt examination was made, the patient sitting unassisted with the left side of the pelvis elevated. (See Figure 2.) This demonstrates the flexibility and muscle power at the lower lumbar joints and shows the extent to which the compensatory curve in this area might be expected to straighten under its own muscle power after correction and fusion of the primary curve above. In this instance only slight correction of the low lumbar compensatory curve is obtainable.

After the desired correction of the primary curve (in this case the maximum obtainable) had been achieved in the wedging jacket, a roentgenogram was taken with a skin marker on the spine of the first lumbar vertebra (Fig. 3). This film was studied to determine the exact extent to which fusion should be done. The final total alignment of the trunk after extension of the fusion into the lumbar area depends upon the alignment within the fusion area and the power of the unfused lower lumbar spine to bring this fusion area into the erect compensated alignment. The balance between these two areas may be visualized by superimposing the proposed fusion area, as shown in the immediately preoperative marker roentgenogram, upon the lower area, as shown in the pelvic-tilt roentgenogram.

In the present instance, allowing for the usual slight loss of correction during the first year after fusion, it will be seen that the lower surface of the third lumbar vertebra (dotted line, Fig. 3) will be very nearly transverse to the axis of the corresponding segment of the trunk. It should sit squarely upon the upper surface of the fourth lumbar vertebra, which, in the pelvic-tilt examination, is seen to be nearly transverse to the body axis (dotted line, Fig. 2). The total alignment of such a combination is good (Fig. 4). Therefore, in April 1934, fusion was extended downward to include the third lumbar vertebra, one vertebra beyond the primary curve.

Figure 4, taken three years after operation, shows the total alignment to be good. All correction has been maintained at each joint except for slight loss between the eleventh and twelfth thoracic vertebrae, and the fusion is solid from the fifth thoracic to the third lumbar vertebra. The result is that which should be visualized on superimposing or setting

up the third lumbar vertebra in the marker roentgenogram (Fig. 3) on the fourth in the pelvic-tilt examination (Fig. 2). The patient is normally active and has no symptoms referable to the spine. Her shoulders are level, and the head and trunk are well centered over the pelvis.

Case 2 (Figures 5, 6, 7, and 8)

L. C. T., female, aged fourteen years, had an "idiopathic" scoliosis, the primary right curve extending from the fifth thoracic to the first lumbar vertebra with the apex at the ninth thoracic. She had had jacket correction and spine fusion three and a half years before admission to this Clinic. Figure 5 shows that the fusion area did not include the whole of the primary curve, but stopped below at the eleventh thoracic, and that pseudarthroses were present at four joints in the area operated upon,—the fourth thoracic to the eleventh thoracic. The deformity obviously had increased or recurred within the area operated upon and at the joints within the primary curve which had been omitted,—the eleventh thoracic to the first lumbar.

A pelvic-tilt examination was made, the patient sitting with the left side of the pelvis elevated (Fig. 6). This showed excellent straightening at each of the joints in the lumbar spine, and justified the expectation that the same thing would occur in proper degree after correction and fusion of the primary thoracic curve.

After jacket correction was obtained, the spine-marker roentgenogram (Fig. 7) was made. This shows the position in which the spine is to be fused. To fuse the minimum area—the extent of the primary curve (the fifth thoracic to the first lumbar)—might give a satisfactory result, but to extend the fusion one vertebra above (to the fourth thoracic) and one vertebra below (to the second lumbar) would give a more nearly ideal result, because the end vertebrae of the fusion would be parallel to each other and transverse to the axis of the trunk. One may choose to extend the minimum fusion to form this ideal area provided that the unfused portions of the spine above and below, and particularly below, are capable of complete spontaneous straightening under their own muscle power. Allowing for slight loss during the first year after fusion, it will be seen in the present case that the lower surface of the second lumbar vertebra (dotted line, Fig. 7) will be transverse to the body axis and should sit squarely upon the upper surface of the third lumbar when the latter has straightened to the position shown in the pelvic-tilt examination (dotted line, Fig. 6). A superimposition of the third lumbar in the marker roentgenogram on the fourth lumbar in the pelvic-tilt examination will obviously not give a good total alignment. In December 1932, the previous fusion was extended to include the second lumbar vertebra and the four pseudarthroses were found and repaired, making the total fusion area from the fourth thoracic to the second lumbar vertebra.

Figure 8, taken three and a half years later, shows the fusion to be solid throughout and the total alignment to be excellent. Considerable

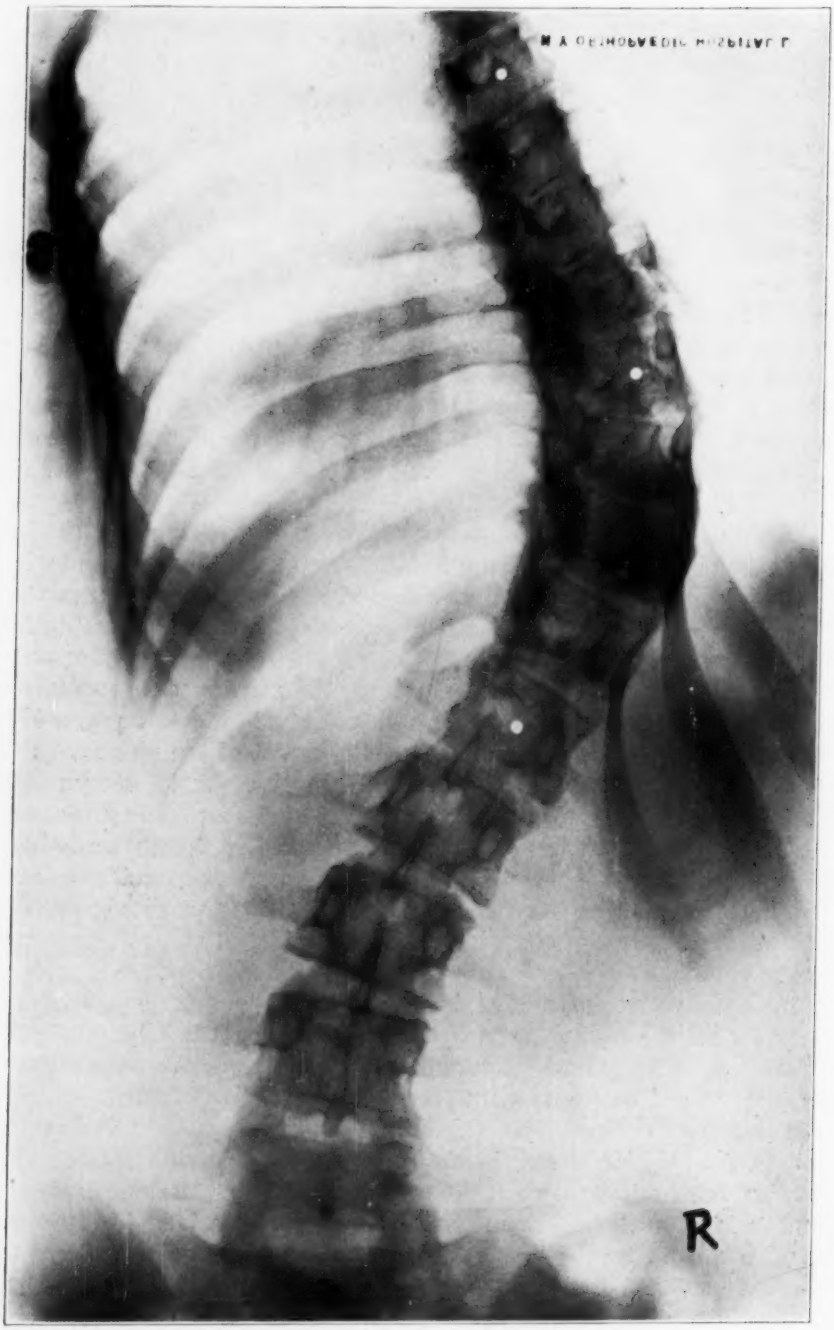

FIG. 5

Case 2. Preoperative roentgenogram, with patient standing.

FIG. 6

Case 2. Pelvic-tilt examination. Patient sitting with left side of pelvis elevated.

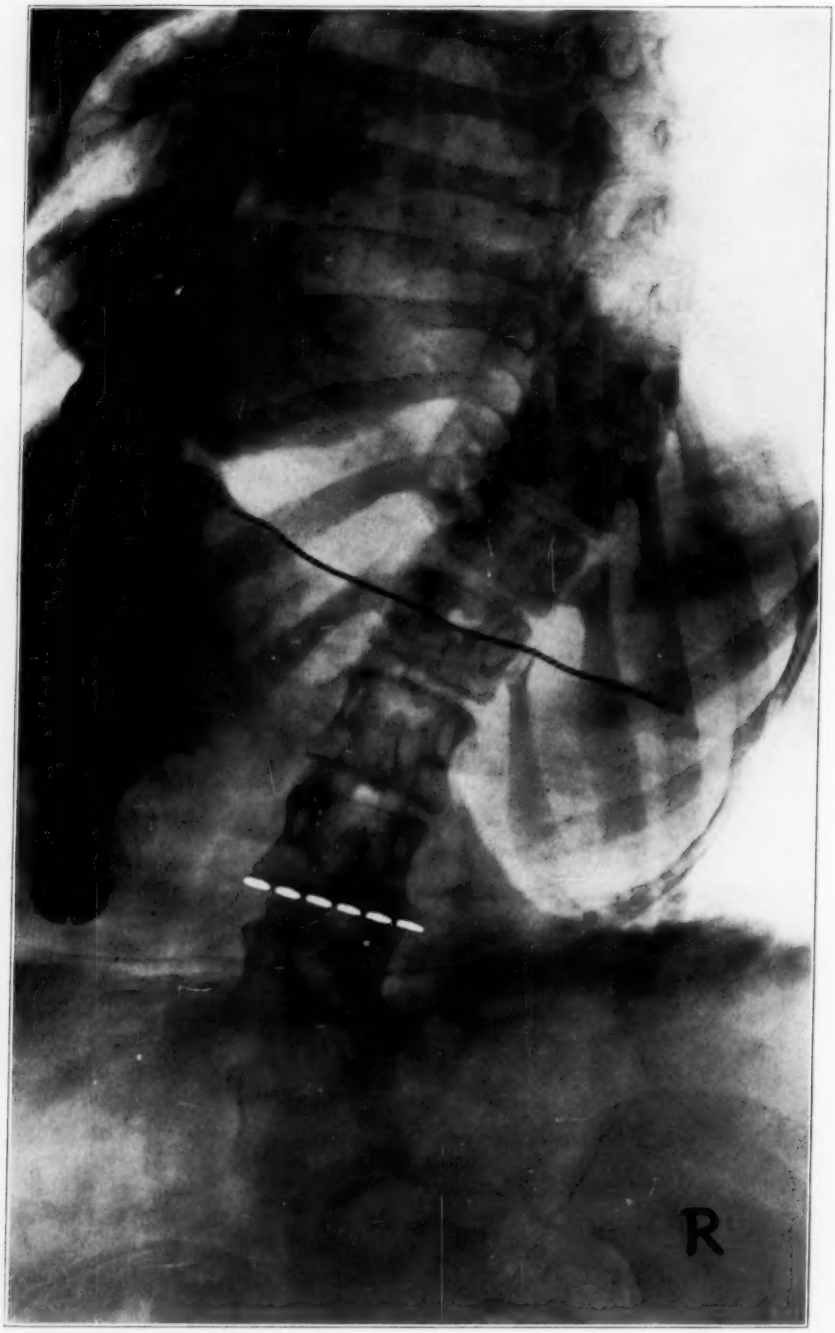

FIG. 7

Case 2. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

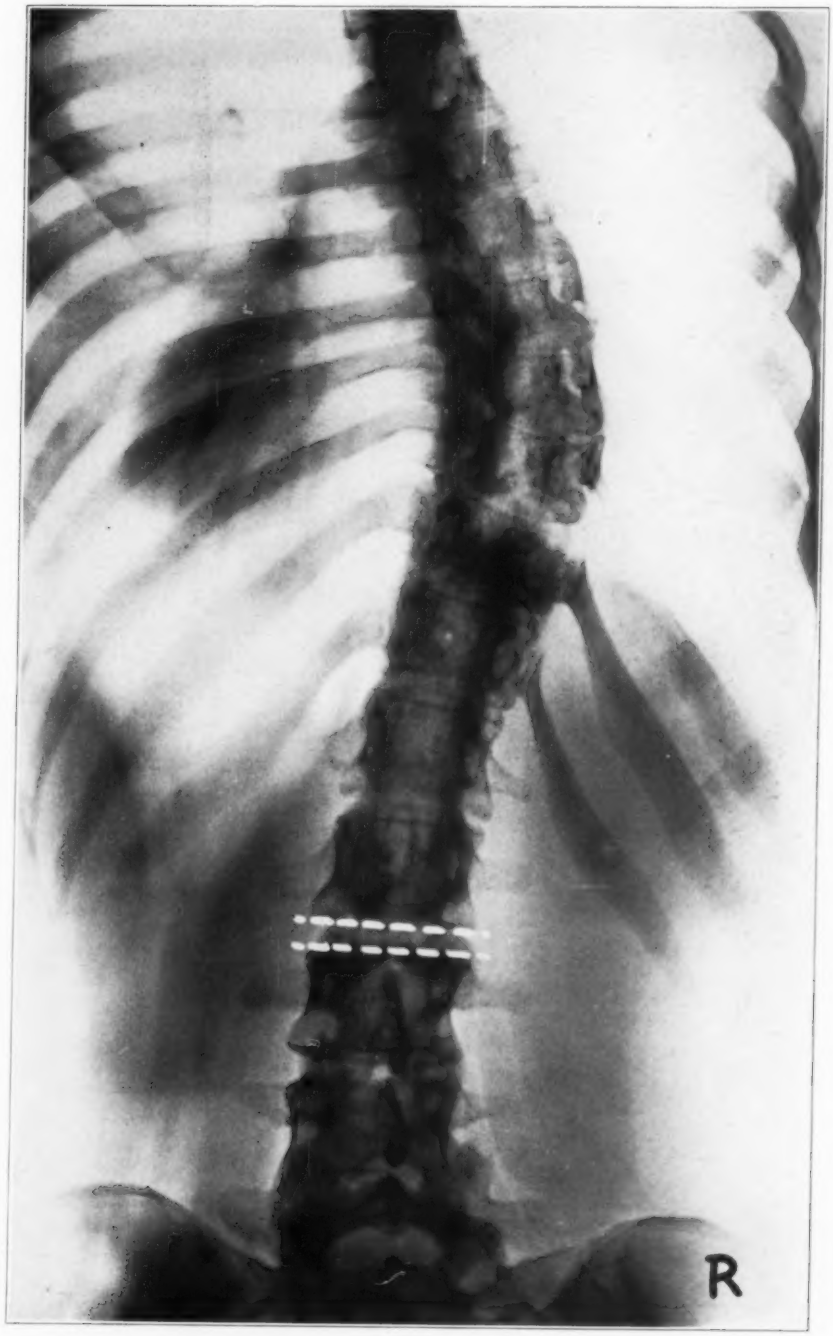

FIG. 8

Case 2. Three and a half years after operation, with patient standing.

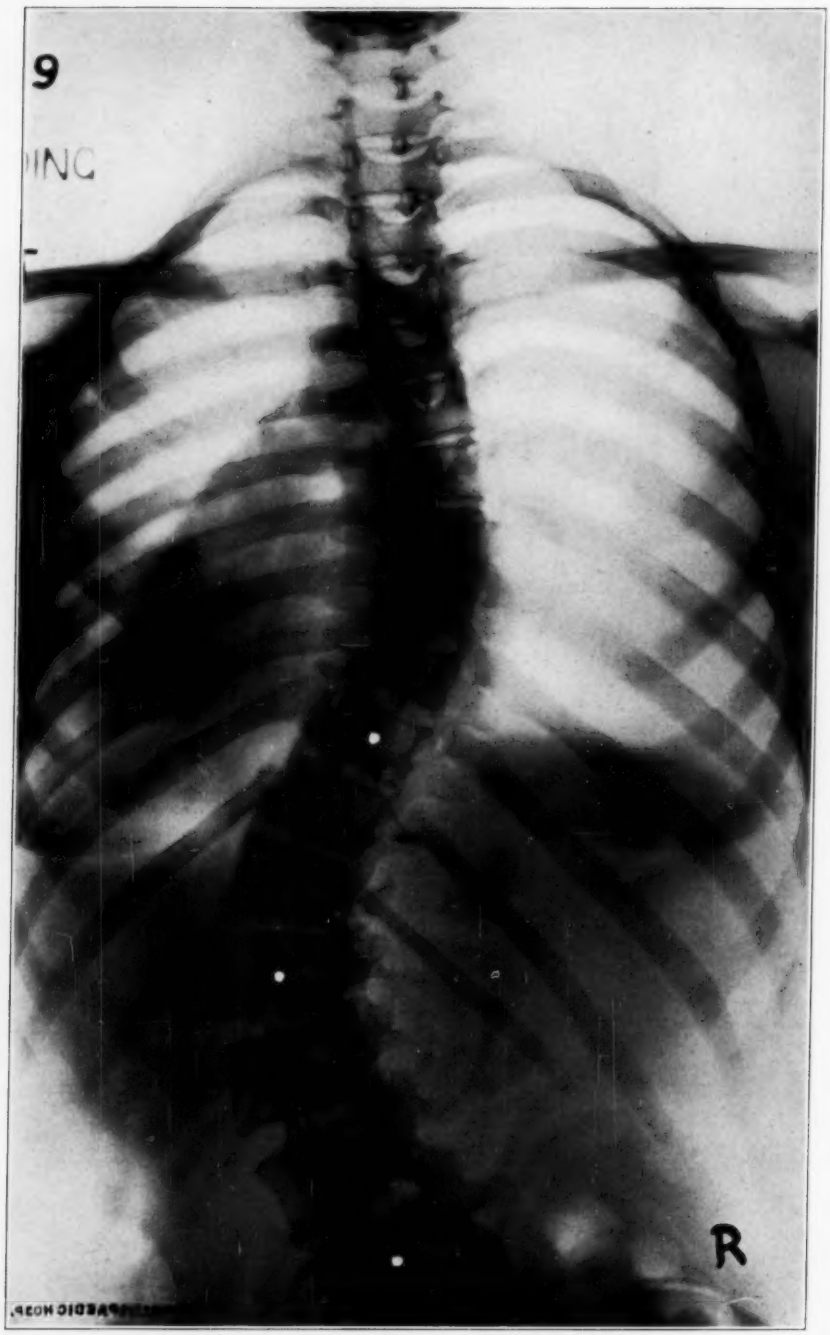

FIG. 9

Case 3. Preoperative roentgenogram, with patient standing.

FIG. 10

Case 3. Three and a half years after operation, with patient standing.

correction was obtained and has been maintained at the sites of the pseudarthroses in the previous area. The patient is normally active and has no symptoms referable to the spine. The shoulders are level, and the head and trunk are well centered over the pelvis. There is good flexibility in the unfused portions of the spine.

Case 3 (Figures 9 and 10)

S. B., female, aged thirteen years, had an "idiopathic" left thoracolumbar scoliosis, the primary curvature extending from the tenth thoracic to the fourth lumbar vertebra, with the apex at the first lumbar vertebra. Only the precorrective roentgenogram (Fig. 9) and the latest postoperative standing view (Fig. 10) are presented to show the undesirability of overcorrection of a curvature and fusion in this overcorrected position. Figure 10 was taken three and a half years after spine fusion from the tenth thoracic to the fourth lumbar vertebra. Note that the original left curve has been converted into a right curve, and that the end vertebrae, particularly the fourth lumbar, are considerably overcorrected,—that is, they now tilt in a direction opposite to that in the original curve. To fuse a curve which has been overcorrected, or even a curve whose end vertebrae have been overcorrected, demands that the compensatory curves above and below the fused area not only straighten of their own muscle power, but actually reverse themselves to maintain good alignment. Overcorrection of a curve or of its ends means for any individual case more correction than the compensatory curves can take care of, and will result in a lateral shift of the body opposite to that present originally. In this particular patient the thoracic compensatory curve (the fourth thoracic to the tenth thoracic) has straightened nearly completely after three and a half years and may eventually reverse itself, but one should not plan for such an eventuality in selecting the fusion area. A curvature should not be fused in an overcorrected position.

Case 4 (Figures 11, 12, and 13)

M. K., female, aged fifteen years, had an "idiopathic" left thoracolumbar scoliosis extending from the eighth thoracic to the fourth lumbar vertebra, with the apex at the first lumbar (Fig. 11). There was a considerable shift of the trunk to the left with moderate prominence of the right hip. The curvature was corrected in the wedging jacket to the position shown in the spine-marker roentgenogram (Fig. 12). From the study of this roentgenogram, it was decided to make the rare exception of not fusing every vertebra in the primary curve, the so-called minimum area, but to leave out the eighth thoracic vertebra from the fusion. This was done because this end vertebra was overcorrected,—that is, its upper surface was tilted beyond a line transverse to the axis of the trunk (dotted line, Fig. 12). Therefore, in 1934, fusion was done from the ninth thoracic to the fourth lumbar vertebra.

Figure 13 shows the end result three years later. The alignment is

FIG. 11

Case 4. Preoperative roentgenogram, with patient standing.

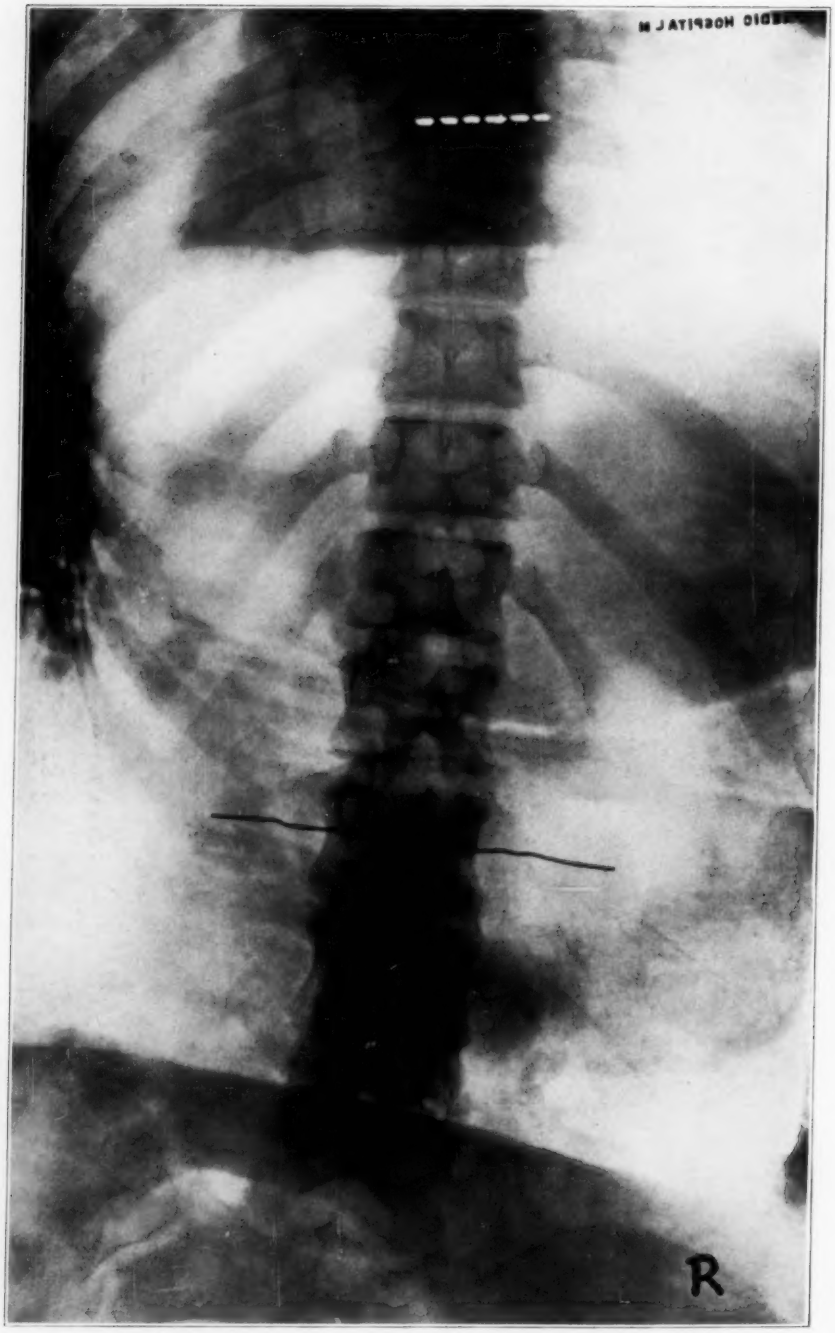

FIG. 12

Case 4. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

FIG. 13

Case 4. Three years after operation, with patient standing.

excellent, and the fusion solid. Had the eighth thoracic vertebra been included in the fusion in its overcorrected position, this would have necessitated a reversal of the upper thoracic compensatory curve for perfect alignment. The omission from the fusion of one of the vertebrae of the primary curve, which was successful in this case, would not have been safe had the patient been three or more years younger, as growth would be expected to cause an increase of deformity at this site.

Case 5 (Figures 14, 15, and 16)

V. P., female, aged seventeen years, had an "idiopathic" right thoracic left lumbar scoliosis, the primary right thoracic curve extending from the fourth to the twelfth thoracic vertebra, with the apex at the eighth (Fig. 14). Marked decompensation and displacement of the trunk to the right and marked prominence of the left hip were noted. The patient had worn plaster casts for two years before coming to this Clinic. A pelvic-tilt examination was not made, as it was not expected that the primary thoracic curvature could be corrected more than enough to restore compensation.

Figure 15, the spine-marker roentgenogram, shows the position of the spine after correction in the jacket immediately before operation. To fuse the minimum area of the primary curve (the fourth to the twelfth thoracic) would probably have given a very satisfactory result. To include one vertebra above and one vertebra below in this instance more nearly approaches the ideal fusion area extending from level vertebra to level vertebra with the transverse axis of each at right angles to the axis of the trunk. Allowing for slight loss of correction during the first year after operation, it was felt that this would not demand more straightening of the compensatory curve below than could be accomplished in this area. Therefore, in 1933, fusion in two stages was done from the third thoracic to the first lumbar.

Figure 16 shows the result three years and ten months later. There is marked improvement in appearance, although by actual measurement the primary curvature is reduced less than 50 per cent. The fusion mass is solid, maintaining nearly all the correction obtained in the jacket. It will be noticed, however, that there is now a slight prominence of the right hip with a slight shift of the trunk to the left, due to the fact that the lumbar compensatory curve below the fusion has not yet straightened enough for perfect alignment. In other words, for this particular case, inclusion of the first lumbar vertebra resulted in somewhat excessive correction at the lower end of the curve. Had a pelvic-tilt examination been made, we should have known how much, or how little, spontaneous straightening to expect in the lumbar curve and would probably have stopped the fusion inferiorly at the twelfth thoracic vertebra.

COMMENT

At the New York Orthopaedic Dispensary and Hospital, from 1928 to the present time, over 400 patients have had wedging-jacket correction

FIG. 14

Case 5. Preoperative roentgenogram, with patient standing.

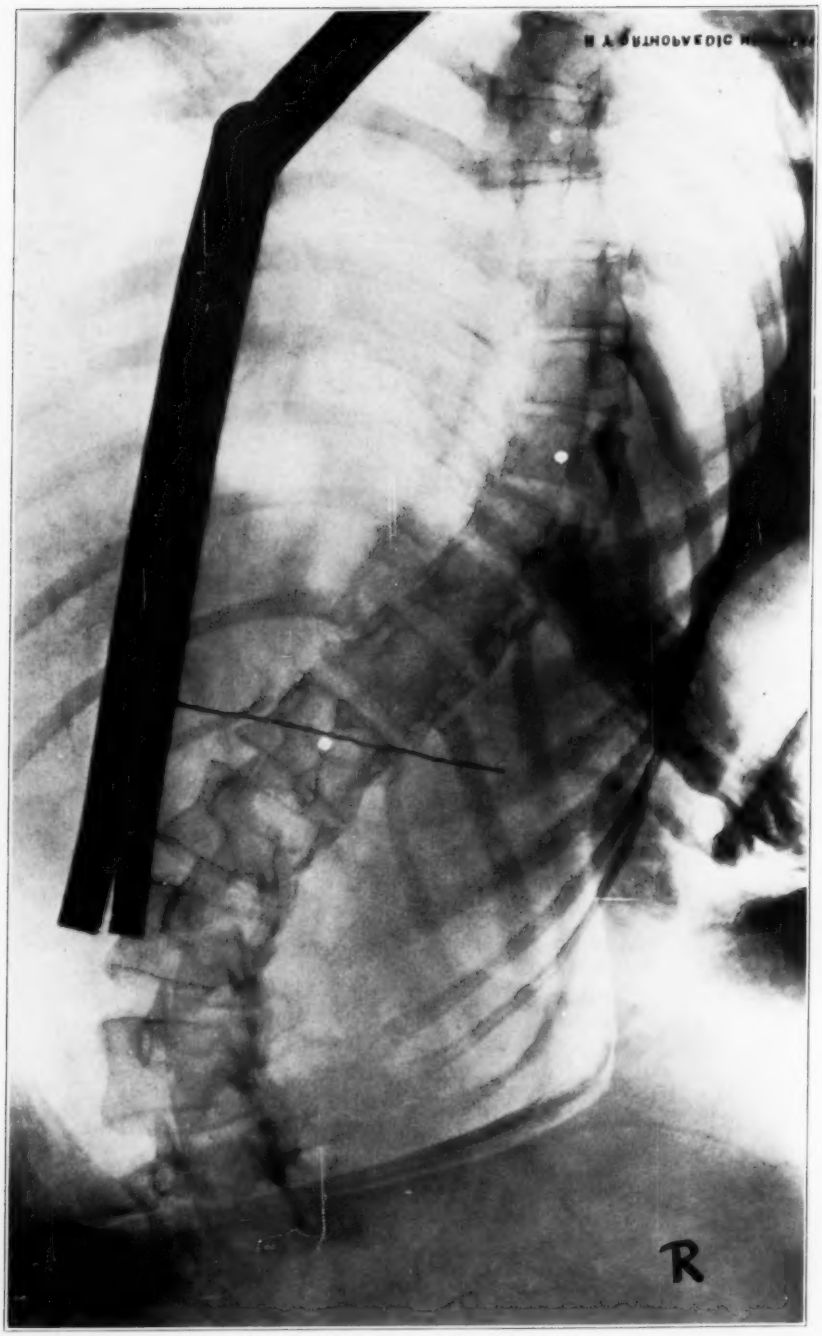

FIG. 15

Case 5. Preoperative spine-marker roentgenogram, with patient in wedging jacket.

FIG. 16

Case 5. Three years and ten months after operation, with patient standing.

and spine fusion for scoliosis. While in many cases the end results have not been as good as could be desired, and while we are continually striving to improve the technique, yet we feel that this method of treatment in selected cases is entirely worth while and gives more striking permanent improvement than any other method at present known to us. The principles discussed in this paper are important factors in securing such results.

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TUBERCULOUS OSTEITIS OF THE ISCHIUM

BY RAGNAR MAGNUSSON, M.D., BORÅS, SWEDEN

From Apelviken Coast Sanatorium, Varberg, Sweden*

As tuberculous osteitis of the ischium seems to be little known, and as only occasional cases have as yet been published, the author feels justified in giving a short account of the eight cases which were treated at Apelviken Coast Sanatorium from 1928 to 1936; these constituted 0.2 per cent. of the cases of bone tuberculosis treated during this period. At the same time, five other cases of osteitis of the ischium, of uncertain etiology, were treated. Three of these are probably to be denoted as cases of clear septic osteitis, while the origin of the other two cases is uncertain. Only a short account of these will be given in connection with the differential diagnosis.

Of the patients suffering from tuberculous osteitis of the ischium six were male and two were female. In five cases the left ischium was the seat of the tuberculous infection; in three cases the site was the right ischium.

The course of tuberculous osteitis of the ischium is insidious and protracted. In the cases upon which this report is based it made its first appearance as slight pain of the sciatica type. In one case (Case 5) the pain started after trauma, and in one case (Case 3) the symptoms set in after childbirth. (As a matter of fact, it has often been observed that a previously latent bone tuberculosis flares up in close connection with childbirth.) During the course of the disease also, the pain, which in most of the cases lasted for a year or more, was of a very mild type, so that the patient was able to go about his work as usual. Later on, however, *localized pain* over the tuber ischii was present; this was especially pronounced when the patient was seated. However, in most cases the pain did not cause much discomfort.

Gradually, abscesses or fistulae appeared in the gluteal region, and not until then did the patient seek medical aid. In one or two rare cases these subjective symptoms occurred periodically, with shorter or longer intervals without symptoms. In one case (Case 2) a fistula appeared in the gluteal region coincident with the setting in of the pain. In nearly all cases the clinical examination showed tenderness to palpation over the tuber ischii, which could also be felt to be raised and thickened.

In two cases (Cases 3 and 5) the patient also had subjective symptoms from the hip joint of the same side as the affected ischium. These symptoms consisted of a sensation of stiffness in the hip joint, at times associated with pain, radiating from the hip joint down along the leg. In addition, it was possible at the *clinical examination* to establish a

* Chief of Surgery: Robert Hanson, M.D.

FIG. 1-A
Case 1

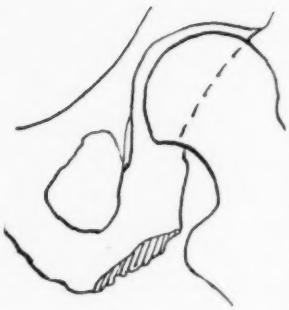

FIG. 1-B
Case 1

restriction of abduction and adduction and of the rotatory movements in one of the cases (Case 7). These symptoms from the hip joint, however, disappeared during the patient's stay at the hospital, and on discharge from the hospital it was not possible in a single case to establish any symptoms of an affection of the hip joint. The roentgenograms of these three cases in which there were symptoms from the hip joint show that the destruction within the ischium reached the acetabulum. (See Figures 3-A, 3-B, 4-A, 4-B, 5-A, 5-B, and 8.) The readiest explanation of the occurrence of symptoms from the hip joint in these cases is, without doubt, that they are due to an irritation from the juxta-articular focus. All three of these patients were operated on. At operation, in Case 3, the destruction of the superior ramus was found to have reached the lower edge of the acetabulum. In

Case 5 the focus reached to within three millimeters and in Case 7 to within scarcely one centimeter of the articular capsule. However, similar juxta-articular foci both of a tuberculous and of an unspecific nature were present in two other cases (Cases 8 and 13) without there having occurred any subjective or objective symptoms from the hip joint, and at operation in each case it was possible to establish that the destruction had reached the acetabulum. On the other hand, pronounced symptoms from the hip joint, together with considerable restriction of mobility, occurred in one case (Case 9) of certain septic origin, in which the changes were principally localized to the tuber ischii (Fig. 8). It is difficult to explain the occurrence of symptoms from the hip joint in some cases, while in others the patients remain free from symptoms under circumstances in other respects quite similar. Quite a number of reasons can be thought of as being of importance in this connection, such as the difference in virulence of the bacteria, less resistance to the infection in some patients than in others, etc. Odelberg, who described four cases of osteitis of the ischium of uncertain origin, stated that in one case the mobility of the hip joint on the affected side was restricted. In this case also the symptoms abated completely. It seems to be quite certain that those symptoms from the hip joint which occur in osteitis of the ischium do not signify the setting in of a fully developed coxitis. The information received from the patients goes to prove the same thing.

FIG. 2-A
Case 2

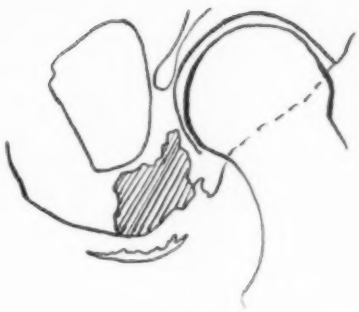

FIG. 2-B
Case 2

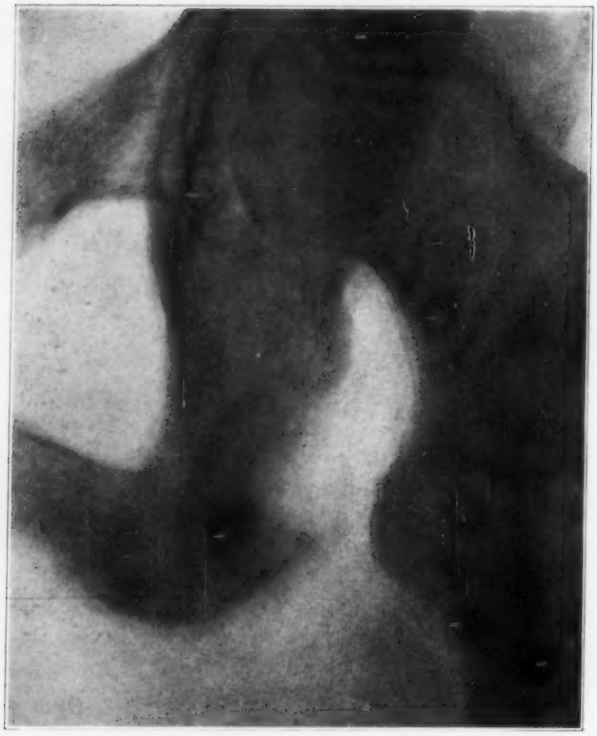

FIG. 3-A
Case 3. Before operation.

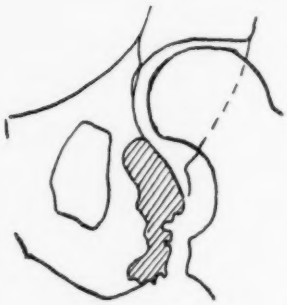

FIG. 3-B
Case 3. Before operation.

Unfortunately, it was impossible to carry out a personal follow-up examination of the patients, as they live in widely different parts of the country. Instead, they were asked to answer a set of questions. Of the eight patients with certain tuberculous osteitis of the ischium, seven replied to the questionnaires. All seven of these patients stated that both of their hip joints were equally mobile. It is true that lesser degrees of restricted mobility may have been overlooked, but this is hardly probable as even very small restrictions of mobility as a rule cause discomfort. The longest period of observation was eight years; the shortest, one year. Of the five patients with an osteitis of unspecific or uncertain origin, four sent in answers to the questionnaires. These patients have also been free from symptoms from the hip joint since their discharge from the hospital.

As none of these patients were brought under observation until they had reached a comparatively late stage of the disease, there are no roentgenograms of the earlier stages. This also seems to be the case in previously published cases of tuberculous osteitis of the ischium. Thus it is possible to give only an account of the roentgenograms of the later stages of the disease. Both the tuberculous and the unspecific forms of osteitis are characterized by wide-spread destruction, in some cases with abundant formation of sequestra. In all of these cases, as well as in previously published cases [1,4,5] of both tuberculous and unspecific osteitis, the destruction was localized to the *lateral part of the superior ramus* or the *lower part of the tuber ischii*. In two of the

cases of tuberculous osteitis (Cases 3 and 5), the superior ramus alone was the seat of the process; and in three cases (Cases 2, 7, and 8), the destruction affected both the tuber ischii and the superior ramus and reached the level of the edge of the acetabulum. In the remaining cases (Cases 1, 4, and 6), the process was principally localized to the tuber ischii and the adjoining parts of the superior ramus. Also, in two of the cases of unspecific osteitis (Cases 10 and 13) the destruction reached the acetabulum. Although in several of the cases juxta-articular foci existed, they do not seem to have had the same catastrophic influence on the joint as do those juxta-articular foci which are situated in the collum femoris, in the greater trochanter, or within the ilium. As has been pointed out, there has been no case in the present series in which a coxitis has developed on the basis of an osteitis of the superior ramus. One may thus consider it especially characteristic of this form of osteitis, whether of tuberculous or of unspecific origin, that it does not lead to coxitis. Osteitis of the superior ramus of the ischium does not show any tendency to ascend and thus break through into the hip joint. This is much more difficult to explain, as in cases of coxitis there is not infrequently found a destruction descending from the hip joint along the superior ramus of the ischium. As recently performed vascular anatomical investigations have shown[2], it does not seem possible, in any case, to explain these facts as being due to the blood supply within the ischium and the hip joint.

FIG. 4-A
Case 3. After operation.

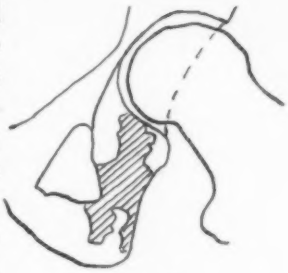

FIG. 4-B
Case 3. After operation.

In the earliest stages of tuberculous osteitis of the ischium—that is, before any objective clinical or roentgenographic symptoms have developed—all those states of ill-health which are generally classified under

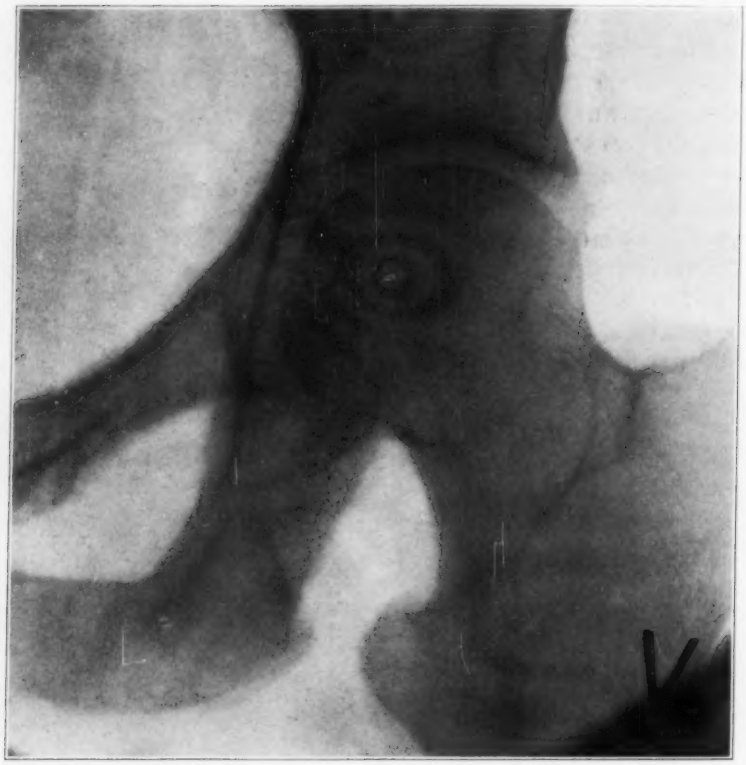

FIG. 5-A
Case 5

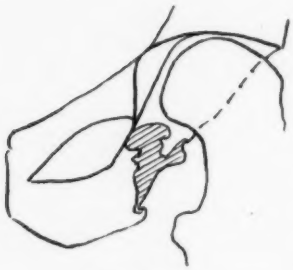

FIG. 5-B
Case 5

the common name of "sciatica" are to be taken into consideration as regards the differential diagnosis. In those cases in which symptoms similar to coxitis have been added, there has as a rule been time for so great changes to develop in the ischium that they are discernible in the roentgenogram, and for this reason there need be no hesitation as to the diagnosis. The same point of view can be applied to those cases in which an abscess or a fistula has appeared. A few patients with well-developed abscesses in the gluteal region were treated under the diagnosis of "dermoid cyst" for quite a long time before their admittance to the hospital. In those cases where there are roentgenographic changes in the ischium but no sequestra, it may often be difficult to determine whether it is a question of an inflammatory process or of a tumor. In order to exclude lues, the Wassermann test should be made.

Of the five cases of osteitis of unspecific or uncertain origin, in two (Cases 9 and 13) the disease made its first appearance in the form of a high

temperature (Case 13 in connection with an angina). This fact, together with the results of other examinations (the tuberculin tests according to Mantoux were negative up to three milligrams of old tuberculin), indicates that these cases probably are to be classified as septic forms of osteitis. A case of septic osteitis described by Pouzet also set in with a high temperature. In the other three cases of osteitis of uncertain origin (Cases 10, 11, and 12), the symptoms commenced gradually and the whole disease had a protracted course, as in the cases of certain tuberculous osteitis. In two of these latter cases (Cases 10 and 12), however, the origin of the process was uncertain. Case 10 was that of a man who, at the age of twenty-three years, started to have pain in the right leg. A few years later, an abscess appeared, which was incised, and a sequestrum was extracted. A roentgenogram showed destruction of the upper lateral parts of the right tuber ischii, as well as a slight atrophy of the whole right half of the pelvis. The destruction had a blunt and blurred outline toward the tuber ischii. As only the tuberculin test according to Pirquet had been made, which was negative, and as continued tuberculin tests according to Mantoux and other examinations (the Wassermann reaction and pathological-anatomical examination) had not been carried out, it was not possible to make a definite diagnosis. The author, however, is of the opinion that the most probable diagnosis is that of tuberculous osteitis. Case 12 was also that

FIG. 6-A
Case 7. Before operation.

FIG. 6-B
Case 7. Before operation.

FIG. 7-A

Case 7. After operation.

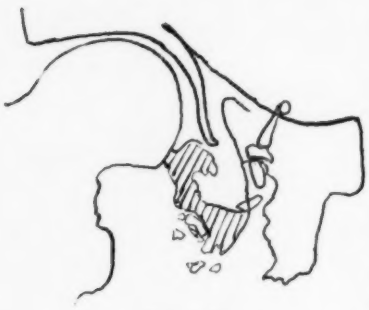

FIG. 7-B

Case 7. After operation.

of a man who, after having received a trauma to the left hip at the age of twenty-eight, had pain periodically over the left tuber ischii. He had been operated on repeatedly. No pathological-anatomical examination, however, had been performed. When the patient was examined at the Coast Sanatorium, the Pirquet reaction proved positive. The Wassermann and Kahn reactions were negative. Probably this is also a case of tuberculous osteitis. This opinion is strengthened by the fact that the patient, as a child, had a definite tuberculous infection (exudative pleurisy). Case 11 is an example of a chronic septic osteitis of the ischium. In most cases it is probably impossible to distinguish a tuberculous osteitis of the ischium from a septic one by mere roentgenographic examination. Nevertheless, the septic osteitis in these cases seems to leave a more sclerotic bone delineation and sharper outlines of the destruction than does the tuberculous osteitis.

Of the eight patients with certain tuberculous osteitis, one was treated conservatively (on account of a very advanced pulmonary phthisis), and the others were operated on. In three of the latter cases (Cases 2, 4, and 6), only sequestrectomy was carried out. In two of the four remaining cases (Cases 3 and 5), gouging, scraping out, and sequestrectomy (Case 3) were performed; in the other two cases (Cases 7 and 8), subperiosteal resection of the tuber ischii

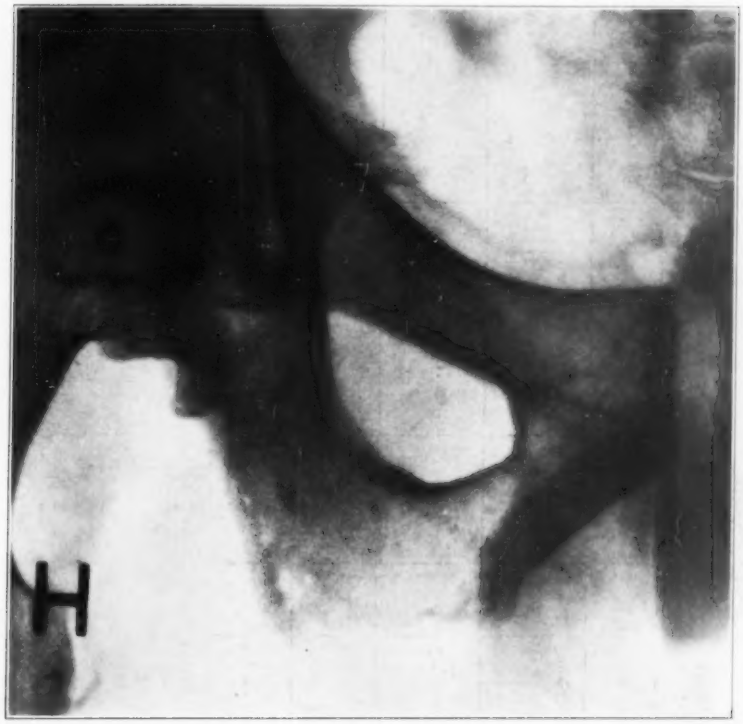

FIG. 8
Case 9

and the adjoining parts of the superior ramus was done. In the latter two cases, the operation was performed under lumbar anaesthesia, with the patient lying in a prone position. The other operations were carried out under ether narcosis. Of the cases of osteitis of unspecific or uncertain origin, two (Cases 10 and 11) were treated conservatively; sequestrectomy and gouging were done in two (Cases 9 and 12); and subperiosteal resection was carried out in the remaining one (Case 13).

In all of the cases operated on the wound was closed immediately. In five of the cases of certain tuberculous osteitis, fistulae were found at the operation. In some of the cases, fistulae appeared shortly after the operation or later on in the operative cicatrix, and in a few cases it was necessary to perform a second operation (sequestrectomy). At their discharge from the hospital all of the patients except two (Cases 1 and 2) were healed. According to the information received from these patients, they have remained healed and otherwise free from symptoms. Milch has recently given an account of the technique used in operations on the ischium. At the gouging and resection in the cases described in this paper great stress was laid on maintaining the periosteum intact as far as possible, in order to secure the circulation from without and thus lessen the chances of the occurrence of new sequestra. The periosteum is cut

TABLE I

CASES OF TUBERCULOUS OSTEITIS

Case No.	Hospital No.	Sex	Age (*Years*)	Localization	Abscess	Fistula	Sequestrum	Treatment	Result at Discharge	Pathological Diagnosis	Follow-up Examination	Fig. No.	Other Localizations
1	924/28	Male	34	Left tuber ischii	None	Yes	None	Conservative	Not healed		Healed	1-A, 1-B	Pulmonary tuberculosis
2	568/29	Male	26	Left tuber ischii and superior ramus of the ischium	None	Yes	Yes	Sequestrectomy	Small fistula			2-A, 2-B	Tuberculous lymphoma of the neck and tuberculosis of the right hip
3	361/31	Female	20	Superior ramus of the left ischium	None	None	Yes	Gouging and sequestrectomy	Healed	Tuberculosis	Healed. No symptoms from the hip joint	3-A, 3-B, 4-A, 4-B	
4	6/32	Male	6	Right ischium	None	Yes	Yes	Sequestrectomy	Healed		Healed. No symptoms from the hip joint		Tuberculosis of the left knee with fistula
5	537/32	Female	22	Superior ramus of the left ischium	None	Yes	None	Excision of the fistula and gouging	Healed	Tuberculosis	Healed	5-A, 5-B	
6	433/33	Male	24	Right tuber ischii	None	Yes	Yes	Sequestrectomy	Healed	Tuberculosis	Healed		
7	338/34	Male	53	Right tuber ischii and superior ramus of the ischium	None	Yes	Yes	Partial subperiosteal resection of the superior ramus and half of the tuber ischii	Healed		Healed	6-A, 6-B, 7-A, 7-B	Tuberculosis of the right knee
8	169/36	Male	35	Left tuber ischii and superior ramus of the ischium	Yes	Yes	Yes	Partial subperiosteal resection of the tuber ischii and the superior ramus	Healed	Tuberculosis	Healed		

TABLE II

CASES OF OSTEITIS OF SEPTIC OR UNCERTAIN ORIGIN

Case No.	Hospital No.	Sex	Age (*Years*)	Localization	Abscess	Fistula	Sequestrum	Treatment	Result at Discharge	Pathological Diagnosis	Follow-up Examination	Fig. No.	Remarks
9	392/30	Male	24	Right tuber ischii and superior ramus of the ischium	None	Yes	Yes	Sequestrectomy and gouging	Healed		Healed. No symptoms from the hip joint	8	
10	610/32	Male	24	Superior ramus of the right ischium	None	Yes	None	Conservative	Healed				
11	143/33	Male	22	Superior ramus of the ischium	None	None	None	Conservative	Healed		Healed. No symptoms from the hip joint		Septic chronic inflammation of the left trochanter. The Wassermann, Sachs-Georgi, and Kahn reactions were negative. The Mantoux reaction was negative to three milligrams.
12	385/33	Male	38	Left tuber ischii and superior ramus of the ischium	None	Yes	None	Sequestrectomy and gouging	Healed		Healed		The Wassermann, Sachs-Georgi, and Kahn reactions were negative. Pirquet's reaction was positive.
13	226/34	Male	17	Superior ramus of the right ischium	None	Yes	None	Partial subperiosteal resection of the superior ramus	Healed	Subacute inflammation without specific changes	Healed		Pirquet's reaction was negative; the Mantoux reaction was negative to three milligrams.

through in the longitudinal direction of the tuber ischii or of the superior ramus and then is carefully elevated by a raspatory. After the removal of all morbid bone, the periosteum is sutured.

The author wishes to express his gratitude to his Chief, Dr. Robert Hanson, for his kindness in placing material at his disposal.

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ACUTE HEMATOGENOUS OSTEOMYELITIS *

BY D. E. ROBERTSON, M.D., TORONTO, ONTARIO, CANADA

The streptococcus and the staphylococcus are responsible for practically all of the cases of acute osteomyelitis. There is a difference in their ability to produce a fatal septicaemia, the streptococcus being responsible for 13.3 per cent. and the staphylococcus for 22.4 per cent. of the cases. There is very little similarity between the two conditions, and unless we make a clear-cut distinction between staphylococcal osteomyelitis and streptococcal osteomyelitis there cannot be any clear understanding of the serological problems that enter into the treatment of the condition. It is useless from the standpoint of treatment to group all cases of osteomyelitis and to consider the mortality of the whole group. (See Table I.) These diseases are entirely different in their clinical manifestations. The great outstanding difference is that there is no necrosis of bone in streptococcal infection, and in staphylococcal infection there is necrosis. In cases of streptococcal osteomyelitis, if drainage is done and if the patients recover, they will get well without the formation of sequestra. We have had no sequestrum occur in a surviving patient. Patients with staphylococcal osteomyelitis practically never get well without the formation of sequestra and are, therefore, more liable to become chronic cases. Forty-two per cent. of our patients under two years of age recovered, and of these 80 per cent. had sequestra. The staphylococcus in its growth produces an exotoxin, a diffusible substance that is excreted from the bacterium. Its potency is extraordinarily high, and its ability to cause necrosis is marked. The rate at which this toxin is produced is highest in the early life of the germ, as is demonstrated in the growing of cultures for the production of toxin. This difference in the two diseases is due entirely to the nature of the toxin produced by the infecting organism and the ability of the staphylococcus toxin to cause necrosis. Its power to cause serious change in the vascular system is the factor that makes staphylococcal osteomyelitis one of the most dreaded diseases occurring in the young. A child who has streptococcal osteomyelitis, if he survives the acute attack, is unlikely ever to have any recurrence or exacerbation. On the other hand, the child with staphylococcal osteomyelitis is liable to both of these contingencies.

Some years ago, in studying cases of staphylococcal osteomyelitis, a routine examination of the blood for its bacterial content was made. If the culture was made a number of times, organisms were grown in every case. Recently it has not been felt necessary to prove the presence of the organisms in every case or to follow out each day the number of colonies that will grow from a given amount of blood. It is obvious that, if the

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

TABLE I

ANALYSIS OF CASES OF OSTEOMYELITIS SEEN AT THE HOSPITAL FOR SICK CHILDREN, TORONTO, FROM 1923 TO 1936

	No. of Cases	*No. of Deaths*	*Per Cent.*
A. Entire Group			
Staphylococcal	277	62	22.38
Streptococcal	60	8	13.33
Total	337	70	20.77
B. Patients Under Two Years			
Staphylococcal	24	14	58.33
Streptococcal	22	4	18.18
C. Patients Over Two Years			
Staphylococcal	253	48	18.97
Streptococcal	38	4	10.52
D. Patients with Staphylococcal Osteomyelitis			
Prior to use of antitoxin	183	41	22.40
Since use of antitoxin	94	20	21.27

disease becomes general from a local lesion in the skin, or the gastro-intestinal tract, or elsewhere, it must find its way by the blood to a bone. Whether twenty or twenty million organisms invade the blood stream may make no difference to the individual whose natural resistance is of a degree sufficient to combat the infection. This natural resistance appears to consist of at least two known agents,—one is the natural antitoxin that neutralizes or renders inert the toxin produced by the organism, and the other has to do with the destruction of the organism by phagocytosis. The former, the natural antitoxin, is very important, as the intoxication from the staphylococcus has a peculiarly destructive power for vascular tissue. It has three toxins,—leukocytolysins, hemolysins, and necrotizing toxins. These toxins, if given in pure form in an experimental animal, may cause death in a few minutes. The presence of these toxins may stimulate the human organism to the production of antitoxin, and, if the intoxication is not too severe, a high level of production of antitoxin may spontaneously be reached.

In addition to the antitoxic property of the blood, there may be another, known as the opsonic action,[9] which is said to prepare the bacteria for ingestion, and it is possible that there is something inherent in the bacterium which has to do with stimulation of phagocytosis. No attempt has been made in this series of cases to show the opsonic indices of the patients, nor has any attempt been made to study the cases according to the differentiation of the white cells (the Arneth formula).

TABLE II

STAPHYLOCOCCUS TITERS OF 120 NORMAL FEMALES

Age of Subject	Range of Titers	Average Titer
6 months	0.1 – 1.2	0.59
1 year	0.2 – 1.0	0.6
2 years	0.3 – 0.8	0.53
3 years	0.3	0.3
4 years	0.2 – 0.75	0.43
5 years	0.8 – 1.8	1.1
6 years	0.3 – 2.8	1.1
7 years	0.2 – 1.8	0.64
8 years	0.2 – 1.8	1.1
9 years	0.1 – 0.6	0.4
10 years	0.1 – 1.5	0.5
11 years	0.2 – 1.8	0.6
12 years	0.2 – 1.7	0.8
13 years	0.1 – 1.8	0.47
14 years	1.0 – 3.6	1.6
15 years	0.3	0.3
20 to 30 years	0.09 – 1.8	0.83
30 to 40 years	0.6 – 1.8	1.2

It is known that the antitoxin of the blood may be definitely measured,[3] and it is now spoken of in terms of antihemolytic units.

Before one may speak of the titer of an individual who is suffering from a disease, the common range of titers in apparent health and in known disease should be determined. Therefore, 305 individuals in apparently normal health, ranging in age from six months to forty years,

TABLE III

STAPHYLOCOCCUS TITERS OF 185 NORMAL MALES

Age of Subject	Range of Titers	Average Titer
6 months	0.27 – 1.25	0.59
1 year	0.2	0.2
2 years	0.2 – 0.5	0.35
3 years	0.2 – 2.2	0.73
4 years	0.1 – 2.8	0.79
5 years	0.1 – 1.8	0.62
6 years	0.2 – 1.7	0.9
7 years	0.2 – 1.7	0.6
8 years	0.2 – 1.7	0.7
9 years	0.2 – 1.8	0.88
10 years	0.1 – 2.2	0.88
11 years	0.1 – 1.8	0.6
12 years	0.1 – 1.8	0.5
13 years	0.2 – 2.2	0.86
14 years	0.6 – 2.4	1.4
15 years	0.5 – 0.6	0.5
20 to 30 years	0.6 – 1.8	0.97

TABLE IV

STAPHYLOCOCCUS TITERS IN SURGICAL CASES OTHER THAN THOSE OF PYOGENIC INFECTION

Affection	No. of Cases	Average Titer
Acute appendicitis	36	0.6
Vermicular colic	15	1.0
Suspect appendicitis	3	0.46
Ruptured appendix	1	0.3
Head injury	17	0.7
Tuberculosis:		
Spine	3	0.26
Glands	4	0.42
Hip	8	0.78
Hernia	8	0.59
Old poliomyelitis	16	0.78
Burns	10	0.94

were studied. (See Tables II and III.) These tables show that there is no great variation in the titer during any particular year or term, and the titers average something under one normal unit. In the ordinary surgical cases seen in the Hospital, other than those of pyogenic infection, the titers were followed. Table IV shows that in these cases there was practically no disturbance of the average titer, except that perhaps in tuberculosis it was lower. In skin infections the titer is usually low; the toxin does not seem to act as an efficient antigen. A study of thirty-seven cases of skin eruptions showed titers varying from 0.1 to 6.0, the average titer being 1.36.

If toxoid is administered to a normal individual, it will be found that his titer is raised. Toxoid is in reality an altered toxin. The addition of formalin to the latter destroys the toxic element, but preserves the antigenic factor. The toxoid which we have used has been furnished by the Connaught Laboratories of the University of Toronto. The titer in a group of nine adults (Table V) was raised as much as sixteen times

TABLE V

STAPHYLOCOCCUS TITERS OF ADULTS WHO RECEIVED SEVEN TO NINE DOSES OF TOXOID

Case	Before Toxoid	After Toxoid	Approximate Increase
G. M. R.	0.09	1.5	×16
E. J. B.	0.6	3.3	× 5
R. S. S.	0.6	3.7	× 6
E. M. M.	0.6	3.5	× 6
J. L. F.	0.6	6.5	×10
A. F.	0.75	10.0	×13
W. R. S.	0.8	7.5	× 9
A. J. B.	1.0	14.0	×14
A. S. B.	1.3	9.2	× 7

TABLE VI

STUDY OF THE ANTIHEMOLYTIC ACTION OF THE BLOOD IN FOUR ILLUSTRATIVE CASES OF STAPHYLOCOCCAL OSTEOMYELITIS

Case	Age (*Years*)	Date	Antitoxin Titer	Remarks
R. W.	7	April 25, 1937	1.0	
		April 27, 1937	1.0	Negative blood culture after April 25.
		April 29, 1937	1.0	
		May 3, 1937	4.0	
		May 7, 1937	8.0	
		May 17, 1937	10.0	
M. M.	10	May 9, 1935	3.6	Negative blood culture.
		May 14, 1935	6.0	
		May 16, 1935	6.0	Metaphyseal abscess drained.
		Toxoid started		No sequestrum.
		May 22, 1935	10.0	
		July 9, 1935	44.0	
H. F.	10	September 20, 1935	0.3	
		September 21, 1935	0.3	
		September 23, 1935	1.0	
		September 24, 1935	3.0	
		September 25, 1935	5.0	
		September 26, 1935	7.0	Positive blood culture until September 27.
		September 27, 1935	12.0	
		September 28, 1935	13.0	
		September 30, 1935	14.0	
		October 2, 1935	17.0	
		October 9, 1935	13.0	
		October 21, 1935	21.0	
		November 11, 1935		
		Toxoid started		
		January 5, 1936	40.0	
		September 30, 1936	10.5	
E. B.	10	May 31, 1935	3.6	
		June 3, 1935	3.6	Negative blood culture.
		June 5, 1935	3.3	Healed without sequestrum.
		June 7, 1935	4.4	
		Toxoid started		
		June 15, 1935	7.2	
		June 19, 1936	12.5	
		March 9, 1937	10.0	

in one case, and as much as five times in the individual who reacted the least. The highest titer before inoculation was lower than the lowest level after inoculation. It is, therefore, possible clinically with one course of toxoid to raise a patient's antihemolytic titer at least five-fold.

No experiments with the administration of vaccines—that is, dead staphylococci—have been done to find the effect, if any, upon the titer of a

normal individual. That is something upon which we are now working. Wright's work on opsonins demonstrated that the opsonic index could be raised by the administration of a vaccine.

In view of the extreme virulence of the staphylococcus toxin, it would appear that a high degree of natural antitoxin in the blood would be an excellent defense against its ravages. Ninety per cent. of deaths from staphylococcal osteomyelitis occur in the first two weeks.[7] While a high degree of natural antitoxin may not be a factor in the direct destruction of organisms, yet it is not unreasonable to suppose that the neutralizing of the toxin will allow other defensive agents to have an unimpaired action in the destruction of organisms. In this way, then, the first organisms that gain entry to the blood may be destroyed or rendered innocuous soon after their entry.

TABLE VII

ANALYSIS OF NINE CASES IN WHICH STAPHYLOCOCCUS ANTITOXIN WAS INJECTED INTRAVENOUSLY

Case No.	Age	Diagnosis	Date of Admission	Date of Injection of Antitoxin	Result
77985	12 years	Osteomyelitis of ilium	May 16, 1935	May 18, 1935	Improved
71219	12 years	Osteomyelitis of left tibia	September 22, 1933	September 22, 1933	Died, September 23, 1933
67310	5 years	Osteomyelitis of left tibia	October 12, 1932	October 17, 1932	Died, October 18, 1932
78045	9 months	Osteomyelitis of mandible	May 20, 1935	May 27, 1935*	Died, May 29, 1935
61149	10 years	Osteomyelitis, multiple lesions	August 6, 1932	August 6, 1932	Died, August 7, 1932
40078	10 years	Osteomyelitis of left femur and left humerus	December 5, 1932	December 5, 1932	Improved
55487	9 years	Osteomyelitis of left femur	September 1, 1932	September 1, 1932	Died, September 8, 1932
67039	2 years	Cellulitis septicaemia	September 26, 1932	September 26, 1932	Cured
66336	11 years	Osteomyelitis of right clavicle and left pubis	July 29, 1932	July 29, 1932	Improved

* This patient received 20 cubic centimeters of staphylococcus-aureus bacteriophage intramuscularly, 70 cubic centimeters of staphylococcus-aureus bacteriophage intravenously, and 100 cubic centimeters of staphylococcus antitoxin intravenously.

A study of the antihemolytic action of the blood in clinical cases where there is staphylococcal infection demonstrates various levels of this power (Table VI). In cases where there is a spontaneous rise, it comes on gradually and may reach great heights. It is reasonable to conclude that the infection stimulates defense in the increasing of antitoxin, and it appears equally true that when the natural antitoxin is at a high level the patient's general reaction is not great. It is said [5] that the administration of prepared antitoxin does not act as an antigen for the production of natural antitoxin, but it would appear that an antitoxin that is available would be a useful agent to introduce in the early stages of an infection into the blood stream of a patient suffering from staphylococcal disease. Unfortunately in our hands this line of treatment has given very questionable results (Table VII), so that it is the practice now not to give antitoxin intravenously. However, we do use it intramuscularly.

The height of the titer is not maintained over a long period in most cases. It quickly falls to a lower level and in a period of months is to be found at the base line,—this, too, in the presence of the infection. It is possible in these cases to raise the level by the administration of toxoid, and, while it is admitted that a titer above normal does not prevent a flaring up of the activity of organisms, it surely must be a factor in neutralizing or minimizing the effect of the toxin produced. We believe that the level of antitoxin should be kept at least three times normal in all cases of chronic or healed staphylococcal osteomyelitis. To this end, regular investigation of the patient's blood is made as frequently as is found to be necessary and toxoid is administered if there are less than three units of antitoxin present. We now have a special follow-up of this sort and hope that in a few years results will be available that will decide the question. We have had no experiences of an adverse nature with the administration of toxoid.

PREVENTION

It should be possible to prevent bone lesions in children who are reasonably supervised by their parents. A child with a skin lesion should be given a course of toxoid, as skin lesions are not prone to stimulate the production of natural antitoxin in the individual. The child also should be limited in his activity to a point where he is not likely to suffer a strain or injury to a joint or bone, as injury and trauma are potent factors in determining the site of a local lesion.

EXPERIMENTAL PATHOLOGY

In the past, there has been done a considerable amount of excellent experimental work which has given a fairly clear picture of the mode of infection and the site of the local lesions.

This disease has been known for ages to be associated with furuncles,—indeed, it has been called furunculosis of bone. Where a pathological process has caused vasodilatation and the consequent increase in blood supply there must be ample opportunity for the infecting organism to be

carried away from the lesion in the blood stream. One may visualize the spread in certain infections by following the course of the lymphatics in superficial lesions of the soft tissues. If proof is needed that a furuncle is not a local lesion, regular culture of the blood of sufferers will reveal bacteria.[2]

In a class with the furuncle, are to be included skin lesions which are the results of infected cuts, blisters, etc. One frequently sees this very definite picture: a skin lesion that has just healed, with the scab still on the surface, on a patient who has been ill for a day or two with an acute infection which turns out to be osteomyelitis. It is interesting to note that one rarely, if ever, finds a bone lesion present and giving symptoms at the time of an active skin lesion. The "seeding" of the bone lesion takes place during the activity of the skin lesion. If the patient has little resistance to the organism, a fatal septicaemia may terminate the affair before a bone lesion can mature.

The clinical picture seems to show clearly that the organisms commonly get into the blood from a local lesion in the skin, rarely from the respiratory or the gastro-intestinal tracts. Why then, and in what situations do the organisms form a deep lesion? Leaving aside for the time being all questions relating to immunity, and turning to the experimental work, one finds that certain facts relating to the circulation in bone have been established. Teruo Hobo, among others, has demonstrated that inert bodies, such as are found in India ink, when introduced into the circulation of an experimental animal, at once cause the mucous membrane to become dark gray. In ten minutes it is again normal in appearance. If animals treated in this fashion are killed at times varying from three-quarters of an hour to as long as seventeen days, autopsy shows that the spleen, the *bone marrow*, and the liver are stained black, while the lungs, the heart, the kidneys, the brain, the nerve tissues, and the gastro-intestinal tract are clear. Microscopically, the small particles are found in the endothelial cells of the medullary capillaries. In the capillary enlargement of the metaphyses of the long bones the particles are so thickly deposited that it is impossible to recognize the phagocytes. In the lungs and the kidneys there are clumps of organisms. There is a lessened power of phagocytosis, or an absence of it, just at the metaphysis, whereas there is an active process in all the endothelial cells of the medullary capillaries. This work clearly demonstrates what Philip Wilson and others have shown,—namely, that there is a definite anatomical area in the vascular system of the metaphysis which permits marked slowing of the blood stream and a sedimentation in the large venous bay. The arterial capillary leading to this bay is very small and it empties into the large venous pool where the stream is very materially slowed. Combined with the slowing of the stream and its relative stagnation, there is a great scarcity of cellular elements of a phagocytic nature. This is the reverse of what is true in the medulla, as the medulla is extraordinarily rich in blood supply, having large venous channels, and is very plentifully supplied with

large numbers of cellular elements of the highest order. Wyssokowitsch has made interesting observations upon the fate of living organisms injected intravenously into experimental animals. He has demonstrated that the blood culture of a rabbit which has been given a lethal dose of anthrax organisms shows: after five minutes, fifteen colonies; in two and one-half hours, no colonies; in forty-six and one-half hours, three colonies; in seventy-two hours, fifty-six colonies; and in eighty-four hours, countless colonies, followed by death. Likewise, in other animals having a similar dose no colonies are found at the end of twenty-four hours, yet at autopsy at this time forty-five colonies have been obtained from cultures from the liver and the spleen. Lexer showed also that organisms introduced into animals create abscesses in the viscera, the muscles, and the bone. Some experimental work done by the author in an endeavor to produce osteomyelitis, using staphylococcus as the infecting organism, demonstrated that if one wishes to engender osteomyelitis a young animal should be used. The introduction of organisms into adult animals caused septicaemia and in some cases arthritis, but osteomyelitis could not be produced. If an animal in its cartilage age was used, there was no difficulty in causing bone lesions in association with lesions of a septic nature elsewhere in the body. In the bone these lesions were found to be located in three places: in the metaphysis, in the medulla of the epiphysis, and beneath the periosteum. The experimental work, therefore, seems to indicate that the local lesion in the bone is most frequently found in the metaphysis, and is due to a combination of slowing of the blood stream and lack of phagocytic elements in the metaphysis. It has been shown that organisms ingested by a phagocyte are not necessarily dead. It is possible, therefore, for organisms to survive over long periods of time in such a location. Moreover, in the microscopic sections taken from animals with experimentally produced osteomyelitis one can find organisms in the cartilage cells of the epiphyseal line, and it is possible for these to remain a very long time in this location under suitable conditions.

If, therefore, a metaphysis is "seeded" from a skin lesion, although the skin lesion heals, the newly formed lesion in the bone develops activity; then it, in turn, soils the blood stream and "seeds" other areas of predilection, so that the result is a continued septicaemia which may produce other local lesions. Lexer found that by using an organism of low virulence he could produce in bone a disease of low activity in that the importance of the infection depended upon the virulence of the organism.

Trauma is well recognized as an agent for devitalizing tissue, and devitalized tissue is very fertile soil for the growth of organisms. Hemorrhagic areas and substances are ideal for the growth of bacteria. Any tissue that has a poor blood supply is very weak in resisting infection. Trauma in an animal which is suffering from septicaemia is likely to produce a local lesion at the site. There are specimens demonstrating this in various laboratories throughout the world. There is one in particular in the Museum of the Royal College of Surgeons, in England,—a bone taken

from a child who was killed in an accident, in which the epiphysis was injured just sufficiently to produce a hemorrhage in it. This would be an ideal place for the location of organisms floating in the blood.

HUMAN PATHOLOGY

The pathological picture presented in a human being is that of an infection of the end of the diaphysis,—that is, of the metaphysis. It occurs only in children and before the epiphyseal line disappears. Periostitis and epiphysitis occur. Epiphysitis is due to infection of the medulla of the epiphysis, and in infants is probably the source of the arthritis that one finds so common. The organisms lodging in the metaphysis produce the exotoxin which has the property of causing necrosis. In this way their local field is very much wider and the local abscess grows quickly and viciously. The exotoxin is highly poisonous, and its circulation in the blood causes general symptoms which are important. With the occurrence of infection in the region of the metaphysis and of the periosteum, pus is formed and the periosteum is stripped up. This stripping of the periosteum pulls out from the haversian canals the outer layer of the cortex, to the blood vessels of which are attached osteoblasts. Some of these remain viable, as they are attached to periosteum with a good blood supply, and, as the toxicity of the organism diminishes, they are able to regenerate and to form new bone. Under the raised periosteum this new bone is known as the involucrum. The dead bone in the region of the abscess now has no living elements, and as time goes on the inflammatory reaction in the living bone at the junction with the dead bone is such that calcium is absorbed from the living bone by the blood, and in this way the separation is accomplished. After the separation of the dead bone, the buds of granulation tissue go out from the living elements and cover the living bone with a granulation-tissue membrane, so that the dead bone is left in a cavity. The drainage of the abscess cavity may be accomplished spontaneously or surgically. In some cases the abscess is very slow in opening and may continue for a very long period of time without drainage of any sort.

SIGNS AND SYMPTOMS

The patient complains of stiffness in the region of a joint. This stiffness within a few hours is changed to definite pain and loss of function. The pain increases and movement in the joint, permissible at first, is soon lost, and the joint is held in a partly flexed position. General reaction supervenes, and the temperature may go to very high ranges. The outline of the joint is not disturbed for the first twelve or eighteen hours, and it may be twenty-four hours before any obvious swelling or thickening is noticed in the region of the joint. Tenderness is present very early and over a very small area. When swelling of the soft tissues occurs, it will be found to be above or below the joint, and as it increases it progresses toward the middle of the shaft. In those cases where the epiphysis is

infected, swelling of the joint cavity occurs, with fluid demonstrable in the joint, and, as the condition progresses, the abscess in the epiphysis may break through into the joint cavity.

In making a diagnosis, the history is of the greatest importance, and a careful examination of the patient must be made to find out whether or not there is a skin lesion which is healing or has just healed. In the typical case the patient has sustained an injury which has caused what may be called a sprain, with soreness in the region of the joint for a day; the patient then apparently recovers, but some days later stiffness returns to the joint, and the acute reaction begins. In such a case, one of two things may have occurred. The patient may have injured the metaphysis which was already "seeded", or he may have caused an injury to the metaphysis which later became "seeded". Injury to the metaphysis is very easily brought about and is produced in the region of joints by virtue of the attachments of the ligaments of the joints in very young individuals. For instance, a hyperextension of the knee will not tear the posterior ligaments of the knee joint, but will injure the weakest part of the structure—namely, the cartilaginous point—pulling it from the end of the diaphysis. Therefore, in the diagnosis of this condition, one must look for tenderness at the part of the diaphysis that has been most liable to strain,—for instance, in the case of the femur one should look in the popliteal fossa, never at the front of the metaphysis.

A patient in whom a reaction occurs four days or longer after a fracture must be closely examined for the presence of a blood-borne infection producing a local osteomyelitis.

The examination of a child is frequently extraordinarily difficult. In the case of a fretful child and distracted parents, or of a badly trained child and mentally feeble parents, it is impossible to make an efficient examination. The author does not hesitate, and believes it is excellent practice, to give such patients an adequate dose of morphine, so that they will doze and one may examine them without any remonstrance. In such a patient in the early stages of the osteomyelitic lesion, at from eighteen to thirty-six hours, one can put a finger on an area, no larger than a twenty-five-cent piece, which is exquisitely tender and upon which pressure will cause the patient to cry out. One can repeatedly come back to this point, getting the same result, and can absolutely reassure himself of the point of tenderness. In such a patient it is generally found that there is movement in the joint which has restriction. The intense pain, the general reaction, the limitation of movement of the joint, and the local tenderness in a patient who has had a skin lesion a short time before, in whom the blood count is raised, are surely proof of an osteomyelitis of a staphylococcal nature.

There are some cases with a history, acute at first, which quiet down and remain quiet over a long period of time. In 1832 Brodie described two cases of bone abscesses that he had seen some years before. The first case he had seen in 1824. A young man, twenty-one years of age, came to

him complaining that for a year or more he had had increasing pain in the lower part of the femur, which became worse at night. On examination the femur showed some thickening, and Brodie amputated the leg. He found an abscess at the end of the diaphysis. Shortly afterward a young man, twenty-three years of age, was seen with the same history, and Brodie suspected that it was a similar case. He made an opening into the thigh, found a thickened periosteum, and, on going through this and into the bone, he found an abscess which contained pus.

This condition, known as Brodie's abscess, is now very frequently seen. When it is found in children, it is close to the epiphyseal line; in adults, it is generally a short distance from the epiphyseal line. The author considers that a Brodie's abscess is a manifestation of a preexisting osteomyelitis and that it has been "seeded" years before.

The writer recalls the history of a boy who came to the Hospital for Sick Children many years ago. He attended the Out-Patients' Clinic for two or three weeks and received treatment for a sprained ankle. It was in the early days of the roentgen ray, and the roentgenogram did not reveal any abnormality. Fifteen years later the boy complained of pain in the lower part of the tibia, and on examination he was found to have a thickened tibia. An abscess was revealed about two inches above the lower epiphysis. It was drained and found to contain staphylococci.

There is no doubt that organisms can reach an equilibrium or come close to an equilibrium in the tissue in which they lie and in the part of the body in which they live. It is a well-known fact that scar tissue associated with a badly infected compound fracture may harbor organisms for many years. It is an extraordinary thing that these infected areas may carry their infection over a long period of years, and cause no increase in titer or symptoms of intoxication. A woman with a Brodie's abscess, giving symptoms fifty years after an acute osteomyelitis, had a titer of 0.4. If a fair opportunity presents itself, the bacteria commence to grow, and they may kill their host in forty-eight hours with a raging septicaemia. One may open a Brodie's abscess which has given no symptoms excepting that of pain, and immediately the patient runs a high fever and gets a general reaction, and a septicaemia may even develop, which is very important. When death follows the opening of such an abscess, one wonders if it is due to the liberation of toxin. If so, these cases would be better treated by a preliminary course of toxoid.

TREATMENT

There have appeared recently in the literature suggestions that in this condition early operation should not be performed. Some years ago the author felt that, if a diagnosis could be made early in the disease, and, if the local lesion could be drained, one could expect an improvement or a limitation of the disease. Formerly, therefore, it was his practice to operate early upon the lesion, and in this connection he considers Orr's treatment a really great advance both from the standpoint of the patient's

comfort and of his own protection. Recently the writer has felt that an early operation gives no help to the patient. The problem in an early case is one of combating a blood infection and dealing with the toxins and organisms that are present, and until some approach to an equilibrium has been reached surgery, in so far as incision of a local lesion goes, has nothing to offer. When the condition has reached a point where pus is present, then simple drainage may be of advantage.

CONCLUSIONS

1. Staphylococcal hematogenous osteomyelitis is a clinical entity.
2. The blood is most frequently infected from a skin lesion.
3. It is a disease of youth, the metaphysis, the periosteum, and the medulla of the epiphysis being infected.
4. Children with skin lesions should be restricted in their physical activities, and toxoid should be administered.
5. Administration of antitoxin intravenously is not a safe procedure.
6. Toxoid will raise the titer in some cases where infection has not done so.
7. No case should be operated upon in which there is not a definite abscess.

The author wishes to express his indebtedness to the Connaught Laboratories of the University of Toronto in which the studies of the blood titers have been made. Dr. C. E. Dolman and Dr. J. S. Kitching especially have been most generous with their assistance. Dr. W. S. Keith also has done arduous work in gathering statistics of the clinical cases.

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A HISTOPATHOLOGICAL STUDY OF THE SYNOVIAL MEMBRANE WITH MUCICARMINE STAINING *

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The recent revival of interest in arthritis and related diseases of joints has placed the cytology and physiology of the synovial membrane once more on a plane of clinical as well as academic importance. According to the American Committee for the Control of Rheumatism [9], "a full understanding of the pathogenesis and treatment of diseased joints must be based on a comprehensive knowledge of the physiology of the joints . . . information on this subject is meager, and only a few workers seem to be putting first things first, going back to essentials". We, therefore, feel somewhat justified in reporting our interpretations of this study. Because of the presence of mucoprotein in normal human synovial fluid [1, 5], an adequate explanation of the sources of these substances will in part, at least, explain the source of the synovial fluid itself and just what rôle the synovial cells play in its production.

The true character of the synovial cells and the mechanism of the production of the synovial fluid are subjects of an ancient controversy. Winslow, in 1753, expressed the opinion that the synovial membrane was composed of glandular epithelial cells and that the joint fluid was a true secretion of these cells. Von Kölliker and Soubbotine later upheld this view; however, the latter worker claimed that he could demonstrate true goblet cells in the membrane, which he held responsible for the secretion of the fluid. Havers thought that the synovial adipose tissue was mucin-producing glandular tissue. Mayeda, among modern investigators, adhered to Winslow's original view.

Bichat, in 1806, said that the synovial membrane was composed of serosal cells, similiar to those lining the pleura, and that the joint fluid was a transudate. This theory later was partially upheld by Todd and Bowmann who also expressed the opinion that the fluid was merely a physiological transudate derived from blood vessels underlying the synovial membrane. Although expressing no definite view as to the nature of the synovial cells, Bauer, Bennett, and Short, in 1933, termed the fluid a simple diffusate derived both from the blood and from the lymph vessels. They based their hypothesis on an important physiological chemical fact,—namely, that the non-electrolyte urea is of the same concentration in the synovial fluid as in the arterial serum.

His and others have maintained that the synovial membrane is of

* Received for publication on July 2, 1937.

endothelial character and that it is a developmental derivative of the second embryonic layer.

Frerichs was able to demonstrate the presence of mucin in the synovial fluid as early as 1846. On the basis of this finding, he concluded that the synovial fluid was a product of mucoid degeneration. It was held that this degeneration was favored by the grinding motion of the joints. Following this important contribution to the subject, Hueter, Hagen-Torn, Hammar, and others emphatically declared that the synovial cells were of connective-tissue origin. Müller, in 1929, adhered to the cellular-disintegration theory of Frerichs, and accepted a connective-tissue origin of the cells.

In 1931, King investigated the synovial fluid from the standpoint of viscosity and colloidal phenomena and was able to extract the mucinous substances. He also made a study of the cells by means of special stains. He concluded that "the structure and function of the synovial membrane are twofold: a connective capsule for binding purposes in which secretory elements are interposed". Jones, in a more recent work, showed that the viscosity of the synovial fluid of animals is due to the presence of mucin, and that, when this substance is removed, the viscosity is no more than that of a simple exudate.

Vaubel, in 1933, made a study of the cells by means of tissue cultures. He was able to demonstrate vacuoles of mucin in the living cells. He also noted chemically the presence of mucin in the blood plasma in which the cells were grown. He concluded that the mucin was a product of a special synovial cell which he designated a "synovioblast". He did not believe that the synovial fluid was a true secretion, but felt that the "synovioblasts" had properties which were similar to those of the so-called chondroblasts of cartilaginous tissue. In the latter, the connecting matrix is held to be a product of the chondroblasts. In contradistinction to Frerichs and Müller, he further held that the mucoproteins were not products of degenerating cells, but resulted from the normal activity of healthy, living cells. This last view has been upheld by King in a recent work on the Golgi apparatus of the synovial cells. It is thought that when the granules of Golgi can be demonstrated in a connective-tissue cell, the cell is alive and carrying out the normal metabolism of a living-cell unit. King found that this structure became enlarged in conditions in which there was an increased production of the synovial fluid. He was also able to show a well-formed Golgi apparatus in synovial cells which were lying free in the joint fluid.

Among the bizarre theories concerning the production of the synovial fluid is that of Banchi who claimed that the joint fluid was formed from the articular cartilage and not from the synovial membrane.

HISTOLOGICAL MATERIAL, METHODS, AND FINDINGS

We have attempted to show the source of mucoproteins in the synovial fluid by means of properly prepared human tissues which were stained

by the standard mucicarmine technique of Mayers, originally described in 1896.

We have studied 168 excised specimens of tissue which included all the tissues of the human body in which one normally expects to find synovial membrane. Twenty-five specimens were obtained from synovia of membranes of joints; in eighteen of these there was evidence of chronic non-specific synovitis, and in seven there was tuberculous synovitis. Fourteen specimens were taken from the tenovaginal covering of the

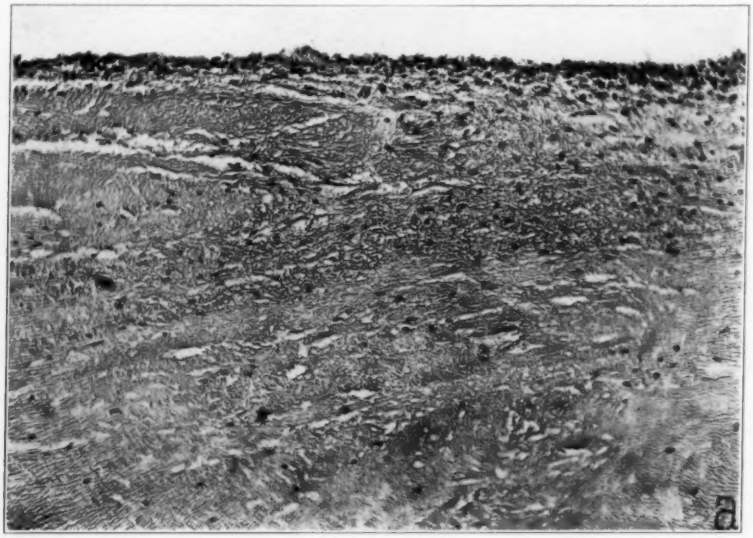

FIG. 1-A

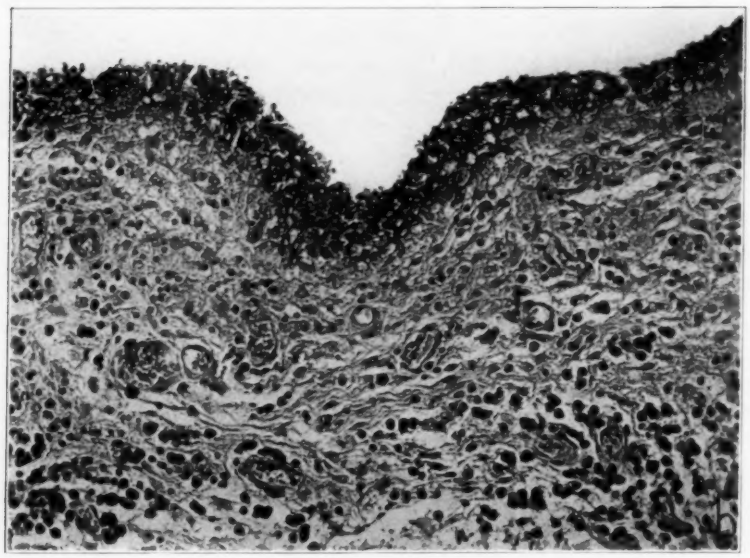

FIG. 1-B

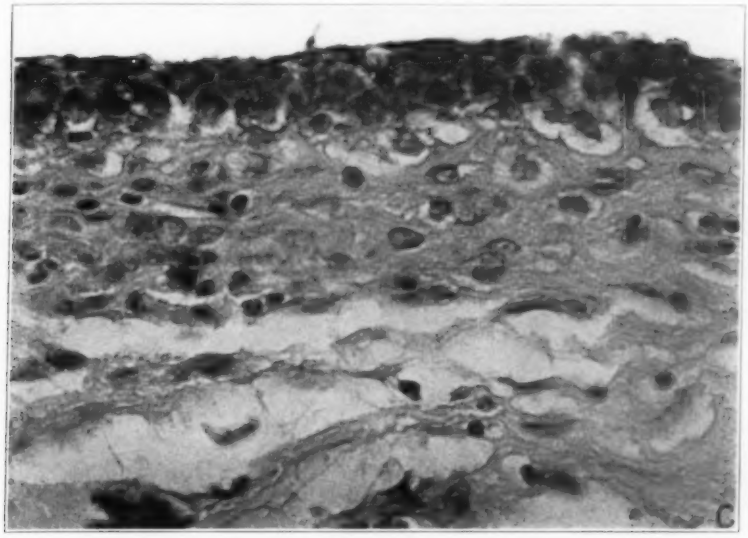

FIG. 1-C
Chronic non-specific synovitis of the knee joint:
Fig. 1-A: Magnification × 105.
Fig. 1-B: Magnification × 178.
Fig. 1-C: Magnification × 490.

tendons; in thirteen of these specimens there was evidence of chronic non-specific tenosynovitis, and in one there was tuberculosis. Thirty-eight specimens were obtained from bursae; in thirty-three of these the bursitis was chronic, in four it was tuberculous, and in one it was gouty. Ninety-one of the specimens were tendon-ganglion cysts. The clinical diagnosis in the majority of the cases corresponded to that made by the pathologist.

We believe that this variety of tissue and the pathological conditions add to the ultimate value of this study.

Among the first observations noted was the difficulty in getting some of the older fixed sections to take the stain. Since this difficulty was not experienced in the more recently removed tissues, with few exceptions, we attributed the failures to the long fixation in the formalin solution used for preservation.

The findings generally noted in these tissues may be summarized as follows: The mucin was found to be present in the synovial layer of the capsule and was not present in the underlying fibrous tissue or in or around the blood and lymph vessels. This can be seen in Figures 1-A and 1-B. The mucin was also noted to be present just at the edge of the membrane next to the articular space, as illustrated in Figure 3. The mucin was more concentrated in the membranous layer than it was in the synovial fluid itself (Fig. 2). The stain was present not only in the cytoplasm of the synovial cells, but also in the nuclei and the intercellular substance, as shown in Figures 1-C, 2, 3, 4, and 5. Degenerating cells found along the

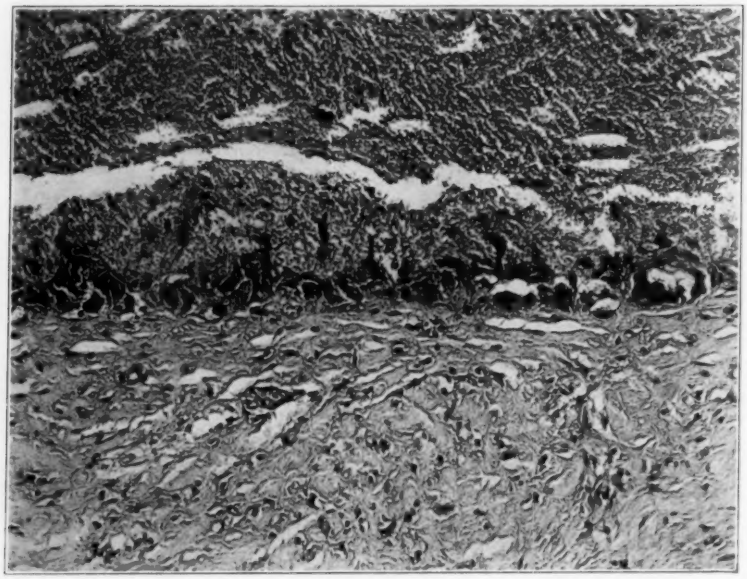

FIG. 2

Chronic bursitis of the olecranon (× 140).

edges of the membrane and in the fluid itself contained mucin, as demonstrated by the presence of the dye (Figs. 1-C, 2, 4, and 5). A control stain used on a section of the glandular portion of the wall of a human stomach showed that the mucin-producing cells of this organ, which are true glandular epithelial cells, took the dye quite differently from the synovial

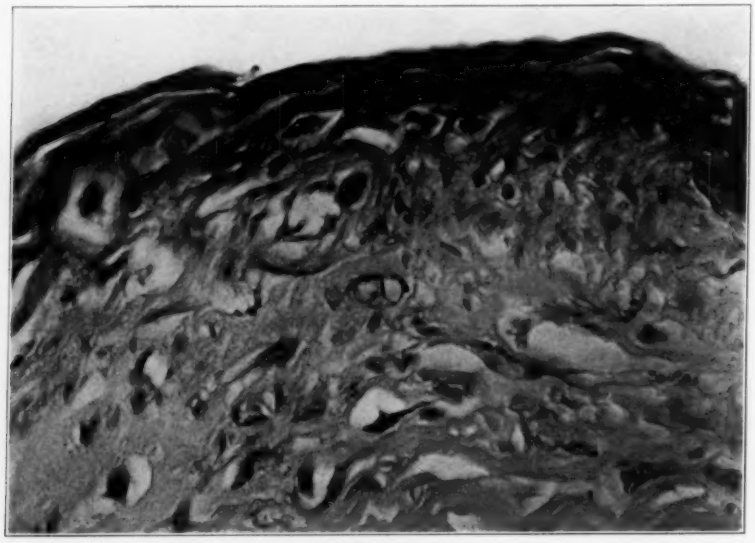

FIG. 3

Chronic bursitis of the wrist joint (× 475).

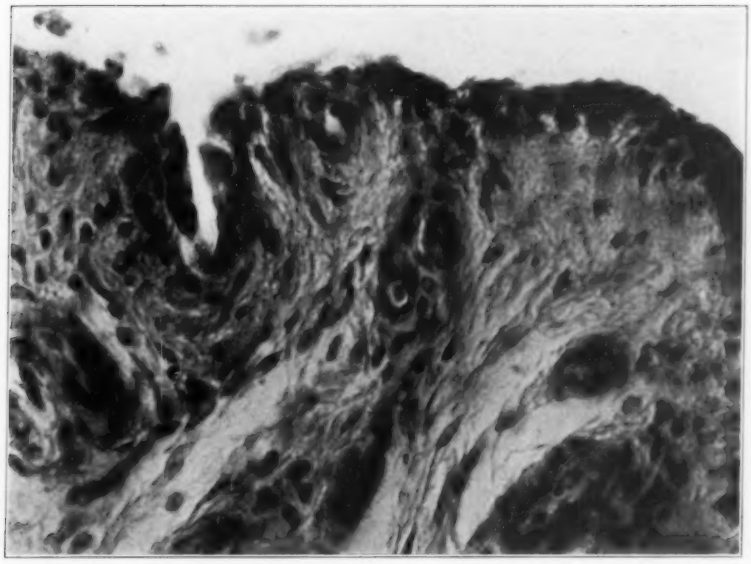

FIG. 4
Ganglion of the wrist joint (× 430).

cells (Fig. 6). The mucin was found to be present with a mottled, uneven appearance in the cytoplasm of the cells of the stomach and was not present in the nuclei. The greatest concentration of mucin was in the portion of the cytoplasm near the acinic space and in the opposite pole from the nucleus. In the synovial cells, on the other hand, the greatest concentration of mucin was in or about the nuclei. Mucin was demonstrated to be present not only in all the structures which contained synovial membrane, but also in sections of these structures in the presence of all the mentioned pathological conditions.

COMMENT

The demonstration of mucin in such a high concentration in the synovial cells is indicative to us that these cells are the main, if not the only, source of mucin in the synovial fluid. (It will be noted that the words "mucin" and "mucoproteins" have been used interchangeably, since it is generally conceded that mucin is a mucoprotein.[19]) Whether the mucin is a product of secretion depends on just what is meant by a true secretion. We usually think of a true secretory gland as one whose product is given up as a result of normal metabolic activity without death of the cell. If the product is a direct result of disintegration of the cellular structure with cessation of normal cellular function, then it is not a true secretion.

There are two main reasons why we believe that the mucin in the synovial fluid is a result of cellular disintegration and not a true secretion: First, innumerable degenerating cells could be demonstrated along the

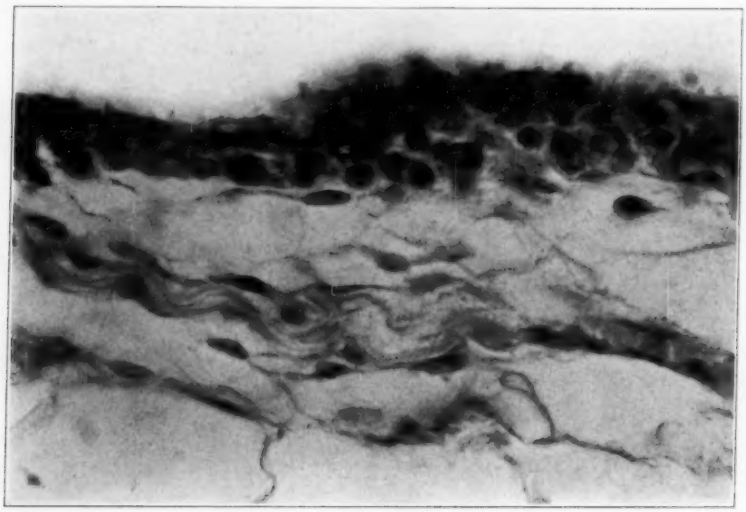

FIG. 5
Chronic bursitis of the knee joint (× 515).

edge of the synovial membrane where the stain appears to be the most concentrated. (Those tissues which had apparently been subjected to rough handling following excision and which had been the victims of a long period of fixation in formalin did not show this phenomenon very clearly. This fact will have to be kept in mind whenever future studies are made.) Second, the appearance of synovial cells which were stained for mucin was different from that of the typical mucin-producing epithe-

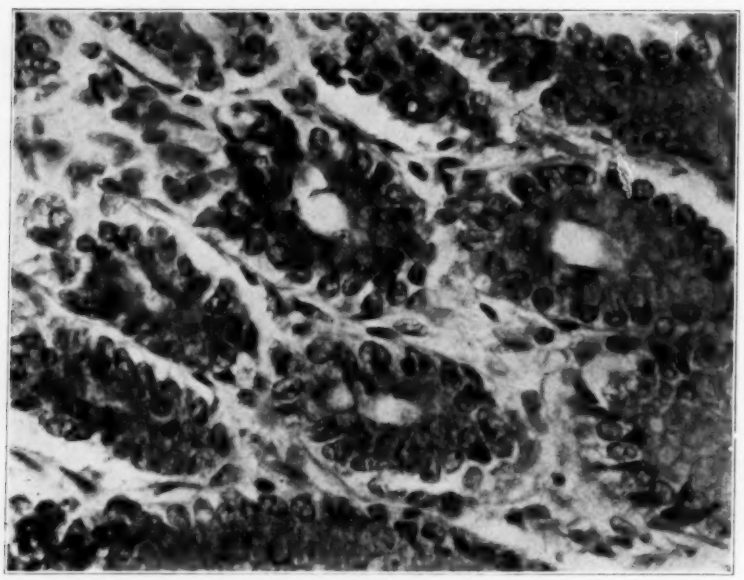

FIG. 6
Section of a normal human stomach (× 430).

lium of the stomach. While the synovial membrane took the stain more or less uniformly throughout the cell and intracellular substance, the gastric cells were stained in an uneven manner in the cellular cytoplasm.

Kernohan was of the opinion that the mucin, together with the other substances of the synovial fluid, is produced by a "myxomatous degeneration" of the cells of the membrane about which there is a rather constant lymph stasis. The factors of trauma, motion, and weight-bearing of the joints are added. This is closely akin to Frerichs' original theory of "mucoid degeneration".

The purpose of this paper is not to consider the source of the synovial fluid as a whole, but to attempt to demonstrate the source of mucin, which is the most important substance in maintaining the proper lubrication of the joints. However, we might venture the suggestion that the composite synovial fluid seems to be the result of a combination of mechanisms rather than of any single one. It would appear that it is a diffusate to which have been added mucoproteins and other proteins in a manner as demonstrated by this paper.

We adhere to that opinion in general acceptance today in regard to the embryonic nature of the synovial cells,—namely, that they are derived from the mesenchyme.

SUMMARY AND CONCLUSIONS

A review of the current literature shows that the nature of the synovial cells and the mechanism of the production of the synovial fluid are still subject to controversy.

The importance of first solving these problems concerning the cytology and physiology of the synovial membrane before further progress can be expected in the study of diseased joints is emphasized.

By using excised portions of synovial membrane obtained from joints, bursae, tenovaginal sheaths, and tendon ganglia, the presence of mucin was demonstrated within the synovial cells.

Studies of these sections lead one to believe that the mucin within the synovial fluid is a product of synovial-cell degeneration.

Adherence to the general opinion that the synovial cells are of connective-tissue origin is acknowledged.

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TENDON TRANSPLANTATION FOR CLAWING OF THE GREAT TOE

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In orthopaedics, as in other branches of surgery, the so-called "minor" disabilities are often the most crippling to the patient and, therefore, "major" to him. One of these, which is common in the late stages of poliomyelitis, as well as in other paralytic conditions, and which has not received from surgeons the attention it deserves, is clawing of the great toe.

The condition is one of plantar flexion of the terminal interphalangeal joint and dorsiflexion of the metatarsophalangeal joint, and each of these joints may reach a stage of irreducible subluxation. This attitude may develop very slowly and insidiously in a foot that appeared normal for a year or more after the acute onset of poliomyelitis, and it is due to minor degrees of faulty balance among the muscles,—that is, weakness of the tibialis anterior associated with overaction of the extensor hallucis longus and flexor hallucis longus, together with weakness of the intrinsic muscles of the foot, especially those acting on the great toe. If the sole muscles are strong, there is usually a cavus deformity of the whole tarsus. The deformity is most liable to occur in the good limb, upon which most of the body weight is borne, due to weakness of the other hip or knee. It is also frequently latent while the patient is at school and is seated a large part of the day, but it develops steadily after he begins work with much standing or walking. Hence its seriousness. What the patient actually complains of is not the deformed appearance, but the corns which occur under the head of the first metatarsal and on the dorsum of the terminal joint. These are likely to be very hard and painful and to resist all the efforts of the chiropodist. When muscle balance is restored by the simple operation to be described, they yield to the simplest measures, such as scrubbing with soda or an application of a salicylic preparation, and they do not recur.

The operation which the author wishes to describe is based on the principle suggested by Sir Harold Stiles[1] during the Great War for the treatment of lumbrical paralysis of the hand,—namely, the creation of an artificial lumbricalis by transferring part of the flexor tendon (flexor digitorum sublimis in the hand) to the extensor tendon opposite the first phalanx, the course normally taken by the lumbricalis, so that it may flex the knuckle and extend the interphalangeal joints.

In the case of the great toe, the present writer began by transferring half of the flexor hallucis longus to a new insertion in the extensor hallucis longus. Later it was found that, if the terminal joint of the toe was subluxated, it was best corrected and fixed by arthrodesis in a straight line. Then it was safe to transfer the whole flexor hallucis longus to the new insertion.

TECHNIQUE

Incision

The incision should be curved like a long-drawn-out S, so as to reduce tension when suturing, and it should run from the internal cuneiform, along the upper border of the abductor hallucis to the side of the great toe opposite the interphalangeal joint,—along the anterior two-thirds of the inner border of the foot, as one must have good exposure to reach both flexor and extensor tendons and to induce them to run a smoothly converging course at the end of the operation. No transplant works well in which the united muscles meet at a wide angle.

Skin flaps are dissected up in both directions, as much as possible in the plane immediately over the tendon sheaths, so as to avoid the large plexus of veins. Some of these must be divided and ligatured, but a tourniquet is not necessary and, since in these cases the circulation is poor, it seems to the writer that the use of a tourniquet jeopardizes the vitality of the thin skin flaps.

Freeing of the Tendons

The flexor tendon is found in its sheath, lying close to the plantar aspect of the proximal phalanx. The sheath is opened, and the tendon is pulled out with a blunt hook and traced up as far as the middle of the metatarsal. The toe is then bent sharply, and the tendon is divided as near its insertion as can be reached without making a skin scar under the phalanx, which might become painful on weight-bearing. The tendon must not be freed too far up the foot, for, if it should slip onto the dorsum of the metatarsal head, it would cease to have its plantar-flexing action.

The extensor tendon is lifted out of its sheath for several inches. If it becomes like a bow-string when the claw attitude is corrected, it must be lengthened by splitting it Z-fashion for several inches. Unless the split is a long one, there will be more separation than one expects and no overlap will remain for suturing of the ends.

Joint Contractures

If free plantar flexion has not been attained in the metatarsophalangeal joint, it may be necessary to divide the dorsal ligament, as no transplant can be expected to correct a deformity; its action is merely to prevent relapse. If the interphalangeal joint is subluxated, it is best to arthrodese it by removing a dorsal wedge, including both cartilages. The position is easily maintained by a single catgut stitch through the soft parts.

Tendon Suture

This can be done when both joints stay easily in the corrected position. The flexor tendon should be made to take a course along the side of the metatarsophalangeal joint, reaching the extensor on the dorsum of the proximal phalanx. Sometimes in severe cases it is hard to make the

tendon reach so far. It can be threaded through a slit in the extensor tendon, or, if the latter has been split and is very thin, as it commonly is in spite of its great activity, then the flexor tendon can be buttonholed and the distal end of the extensor tendon passed through it, the proximal end being sutured to the side of the junction. No. 120 linen thread makes the most convenient and least irritating form of suture. The skin is so thin over the line of union that any absorbable material like catgut is liable to irritate the skin and to work its way out. The linen becomes buried in scar tissue and is found with difficulty at any later exploration. No attempt should be made to suture the tendon sheaths, which are usually adherent and inelastic in these cases; a new sheath speedily forms and assists instead of hindering movement.

Skin Suture

Suture of the skin should be by interrupted stitches of silkworm gut, so as to allow free oozing, for, if a hematoma should form under tension, the skin would slough and jeopardize the vitality of the tendons beneath. After correction of the deformity, the skin is surprisingly tense in such cases, especially over the metatarsal head. In some cases a blister has occurred in this region, but exposure to the air under a wire cage for a few days (Böhler's technique) has dried it up without loss of skin or undue adherence. The skin stitches should be left in for from twelve to fourteen days.

Splinting

A firm bandage over plenty of wool is sufficient to fix the great toe in neutral position, but, in order to discourage movements of the tendons for ten days, a splint to hold the ankle at a right angle is useful.

After-Treatment

In order to give opportunity for the most favorable circulation, the patient should be kept in bed for three weeks with the limb raised on a cage. After this he can walk in a boot which is sufficiently long and wide to give room for the corrected great toe. Massage, to free light adhesions without bursting open the wound, is useful, but an intelligent patient can soon restore good movement by exercises in hot water.

RESULTS

It is not claimed for this operation, any more than for any transplantation operation, that it will restore normal function, but in the writer's hands in every case it has relieved the pain and disability associated with corns and arthritis. There have been no relapses and improvement has been steady. The earliest case was operated upon about five years ago. All of the patients are working, and, before the operation, most of them seemed likely to have to give up work as the result of the deformity. Although the passive range of the great-toe joints may be normal after oper-

ation, provided that severe arthritis has not involved them before operation, yet the active range will be only about 20 degrees in each direction from neutral, the two phalanges moving as one rod about the metatarsal head. This is the amount required for walking and standing.

COMPLICATIONS

In a certain number of cases there is a similar claw attitude of all the toes. If the toes are not fixed and the corns are not painful, the deformity can be ignored. If the sole muscles seem fairly good and the extensor tendons alone are shortened, tenotomy may restore balance.

In more severe cases, it would be too tedious to do a similar transplantion operation on each toe, whereas excellent balance can be obtained by Hohmann's operation of looping the extensor digitorum longus tendons around the neck of the third or fourth metatarsal. A separate incision must be made for this,—a J-shaped incision along the fifth metatarsal is best. The tendons are cut at the root of the toes; the periosteum is raised around the neck of the metatarsal with an aneurysm needle; and, after the tendons have been secured with guide threads, these threads are used to pull the tendons in pairs around the bone from opposite sides. Two stitches then suffice to anchor the ends together, while the ankle is kept at a right angle. The extensor digitorum brevis tendons should be left intact to prevent dropping of the toes themselves. This is a simple operation of astonishing efficacy.

CONCLUSIONS

Clawing of the great toe is a disabling complication of some cases of poliomyelitis and other forms of paralysis. It can be satisfactorily corrected and relapse can be prevented by transplantation of half or all of the flexor digitorum longus tendon into the extensor hallucis longus tendon. If the other four toes are also deformed, they are best treated by looping their extensor tendons around the neck of one of the metatarsals.

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CHONDRODYSPLASIA (OLLIER'S DISEASE)

A Report of a Case Resembling Osteitis Fibrosa Cystica *

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The present concept regarding parathyroid pathology in generalized bone disease was discussed by one of the authors in a recent report of osteitis fibrosa cystica. It is the purpose of this paper to report conditions where the resemblance of chondrodysplasia to osteitis fibrosa cystica might lead to confusion as to the diagnosis.

HISTORICAL REVIEW

Ollier, in 1899, first described a case of a cartilaginous dystrophy in which the extremities of one side of the body were involved. In 1900, his pupil, Molin, described three similar cases,—two of Ollier's and one reported by Nové-Josserand and Destot. In one of these cases, instead of the "hemiplegic" distribution, there was a crossed distribution, the right lower and left upper extremities being involved. Since that time a number of contributions on this condition have appeared. Bentzon, in 1923, described lesions confined to the right lower extremity. He did experimental work on rabbits, injecting irritants near the nutrient arteries of the tibia and the fibula, and developed the theory that Ollier's disease may be interpreted as the typical reaction of the bones to an active hyperaemia of the bone tissue, resulting from anomalies in the sympathetic nervous system. However, it is generally felt at the present time that the etiology of this condition is unknown.

Ollier's disease has been frequently confused with multiple cartilaginous exostoses (also called "dyschondroplasia" and "diaphyseal aclasis") and has been regarded by some as the same disease. However, no good reasons have ever been stated for this claim. Diaphyseal aclasis has a hereditary history in 65 per cent. of the cases, whereas in Ollier's disease this history is almost universally absent. The distribution and morphology of the lesions are also entirely different and bear only the slightest resemblance to Ollier's disease. A number of cases have been reported, the nature of which cannot be accurately defined at present, but which are probably an intermediate type. Ollier's disease is characterized by the presence of areas of cartilage in the shafts of the long bones, especially near their rapidly growing ends, which in roentgenograms have the appearance of gouged-out areas, while in other places there seem to be

* This study was aided by a grant from the Christine Breon Fund, University of California.

rounded cystic areas. Several authors, who have reported histological findings in portions of excised bone, are in agreement that the rarefied areas consist largely of hyaline cartilage.

Much has been made of the question of nomenclature, most authors stating that the term "Ollier's disease" should be reserved for cases which show an asymmetrical involvement, approaching a unilateral involvement, as an outstanding feature. This has been done in spite of the fact that in one of Ollier's original cases there was a crossed distribution affecting one leg and the opposite arm.

The case report which follows shows the symmetrical involvement of both legs and almost every bone in one arm. The other arm is free from involvement. This patient has been under observation at the Stockton Crippled Children's Clinic for the past five years. During this time roentgenographic studies have been made to follow the development of the disease. The case constitutes a connecting link between Ollier's disease, which involves only one side of the body, and chondrodysplasia, a term applied to the same condition when it involves both sides of the body symmetrically. Obviously, this case does not demonstrate that type of chondrodysplasia associated with cartilaginous exostoses. There has been a gradual increase in the degree of bone involvement during the five years in which the patient has been under observation, as well as some spread of the lesions to bones not apparently involved previously.

CASE REPORT

F. S. was a well-developed, healthy appearing male. His birth history was negative and he had had no early disease. He had been artificially fed; after four months he had been given cereals, but no vegetables until he was eight or nine months of age. No antirachitic therapy had been given. His development appeared to be normal and his legs were straight until his third year. He was brought to the Stockton Crippled Children's Clinic at the age of four years and examined for the complaint of knock-knee. Roentgenograms of the knees then showed a frayed-out rachitic type of epiphyses with a peculiar cross-striated appearance of the ends of the diaphyses adjacent to the knees, and the lower ends of the femoral diaphyses looked gouged-out. The affection was first diagnosed as an unusual case of rickets. This was two years before the true condition was recognized. Subsequent roentgenograms showed involvement of each end of both tibiae and femora, characteristic radial striations in both ilia, involvement of two ribs on the right side, and of the right humerus, radius, ulna, and several phalanges and metacarpal bones. No involvement of any bone in the left arm was found, and the skull and spine were entirely negative. In 1932 the patient had a pathological fracture of the right femur, and a year later he sustained a second fracture in the same area. Both fractures healed in the usual time.

Physical examination of this patient at the age of eight years and eleven months, when admitted to the University of California Hospital, showed a well-developed and well-nourished boy, healthy and robust in appearance. He walked with a decided limp, and there was a definite though not severe genu valgum on the left and a moderate genu varum on the right. The latter was caused in part by a moderate outward bowing in the lower third of the right femur following the pathological fracture. The shafts of the femur were palpably enlarged. The head was normal in contour. There was a slight retardation in the development of the teeth. Examination of the ears, the throat, the neck, the heart, the lungs, and the abdomen was negative. The reflexes and neurological

examination were negative. There was no deformity of either arm and no shortening of the right arm, in spite of the marked involvement. All joints in the body had a normal range of motion. The legs were somewhat deformed, as already described, but there was no inequality in leg length.

The laboratory data were as follows:

Red blood cells—4,100,000

Hemoglobin—90 per cent.

White blood cells—5,200

Polymorphonuclear leukocytes—67 per cent.

There were no pathological cells. The Kahn test and urinalysis were negative. The tuberculin test—human and bovine, 1:1000—was positive. The basal metabolic rate was minus 4 per cent.

The roentgenograms showed the changes characteristic of this condition,—the longitudinal striation affecting the ends of the diaphyses of almost all the long bones in the three involved extremities, the cross striations, the gouged-out appearance in places, the irregular spotted areas of secondary calcium deposit (especially in some of these apparently gouged-out places), and numerous spherical areas having the appearance of bone cysts as seen in osteitis fibrosa cystica. There was also noted the fan-shaped striation in the wings of the ilia, as described by Bentzon and others.

Characteristically, there was no involvement of the carpal or tarsal bones. Multiple enchondromata of the long bones of the hands and feet, frequently present in these cases, were evident only in mild degree in a few areas, and these lesions seemed to show a high degree of development according to our series of roentgenograms.

Because of the recent tendency to remove parathyroid glands in generalized bone conditions characterized by cyst formation and deformity, it seemed important to make observations on the calcium and phosphorus metabolism. These observations were carried out according to the method of Bauer and Aub.

The patient was placed on a low-calcium diet from September 26 to 29, 1935. Analyses during this time are compiled in Table I.

The levels of calcium, phosphorus, and phosphatase in the blood were within the limits seen in children of this age. There was a negative balance of calcium, although much less than that of the normal adult. A minimal amount of calcium was excreted by the kidneys, the loss being preponderantly by way of the bowel.

In this case the shortening and expansion of the ends of the long bones, described in many of these cases, were not present, but probably the process has not yet progressed to that stage of the disease. It is also possible that the deformities have been somewhat minimized by protection

TABLE I

METABOLISM STUDY OVER A THREE-DAY PERIOD

	Stool	Urine	Total Output	Intake	Balance	Blood
Calcium	0.4400	0.0104	0.4504	0.1875	−0.2629	10.8 10.9
Phosphorus	0.7400	1.0780	1.8180	1.2840	−0.5340	4.72 4.85
Phosphatase						11.0 11.5

for some years against too much weight-bearing and also by consistent administration of vitamin D.

Cole states that "many roentgenograms of cases of proved osteitis fibrosa show a condition in the bone which simulates very closely that seen in some of the reported cases of chondrodysplasia". The case reported here suggests this on superficial examination, although absence of a generalized granular osteoporosis and generalized cortical thinning should be considered. Clinically there is also lacking the usual asthenia

FIG. 1

Symmetrical involvement of both tibiae. Linear streaking is obvious in both. The middle portion of the shafts is without evidence of demineralization, mottling, streaking, or punctate areas.

and weakness, polyuria, and anaemia, which are characteristic of Recklinghausen's disease.

The metabolism study shows no radical departure from the normal, which offers a definite differential criterion from osteitis fibrosa cystica where hypercalcaemia, hypophosphataemia, elevated phosphatase, and a markedly negative calcium balance are associated with preponderant urinary excretion of calcium.

FIG. 2

The right radius is thickened and in the lower portion the typical streaked and mottled cystic area is obvious. The ulna is less striking, but presents an appearance more easily confused with osteitis fibrosa cystica except for the normal mineralization of the upper shaft. (The roentgenogram of the bones of the left arm is not shown as these bones were entirely normal.)

COMMENT

Ollier's disease is a term which has been used to denote certain asymmetrical cartilaginous dystrophies of characteristic appearance and distribution, best revealed by the roentgenogram. Roentgenographically, there may be confusion with some cases of osteitis fibrosa cystica, of either generalized or focal type. Xanthomatosis may also present some difficulty in differential diagnosis, but may be identified by biopsy. (Studies of xanthomatosis will be reported later.)

The involvement in the case reported is both symmetrical (legs) and asymmetrical (arms) and clearly demonstrates that symmetry is of no diagnostic import. The disease consists of cartilaginous lesions, which tend to become grouped, first, in individual long bones, and, second, in extremities. The reason for this is not clear as the etiology is unknown. Where more than one extremity is involved, the tendency to affect whole extremities naturally results in either symmetry or asymmetry. In a search of the literature, unfortunately, symmetrical cases have been discarded as not belonging to this group, so that any attempt at statistical conclusions on distribution is misleading.

The disease runs a characteristic course and reaches a stage where the ends of some of the long bones become expanded, grossly deformed, and shortened. In the case reported, the deformity became evident at the third year, but did not become prominent until later. There was a gradual steady increase in the extent of the individual lesions, as well as some spread in their distribution.

There is at no time in the course of this disease a stage where it resembles multiple cartilaginous exostoses, called also "hereditary deforming chondrodysplasia". The nomenclature is confused, since the term "hereditary chondrodysplasia" is also used to describe those cases where there are associated multiple exostoses. "Achondroplasia", in which there is deficiency in the processes of length growth of the long bones, is also frequently called "dyschondroplasia".

Differentiating Ollier's disease on the basis of asymmetrical distribution adds to the confusion. It would seem much more logical to group all the endochondral cases under the term "Ollier's disease", or possibly "endochondrodysplasia". Those associated with exostoses or ecchondral cases, could then be termed "ecchondrodysplasia". This would be particularly permissible, since in one of Ollier's "asymmetrical" cases there was a crossed distribution, one leg and the opposite arm being affected.

The calcium balance in the case reported was strictly within normal limits, thus further differentiating the condition from osteitis fibrosa cystica, which it resembles slightly. This would indicate that if any enlarged parathyroid glands are found in such cases they are due to secondary hyperplasia and should not be removed.

Treatment at the present time is largely that of corrective ortho-

paedics. Fractures and deformities are frequent. While there have not been many reports of cases followed through adult life, the prognosis is apparently good.

Since these cases are rare (Cleveland in 1928 reported in the literature only fifteen asymmetrical cases of Ollier's disease), only very tentative conclusions can be drawn from our present knowledge. It is important that further cases be reported in an effort to establish the nature of this condition and its relation to the various other cartilaginous and osseous dystrophies.

NOTE: Since this study was made, a rather extensive discussion of a similar nature has been reported by Mahorner.

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A REVIEW OF SYNOVECTOMY*

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Synovectomy may be described as an operation for the removal of diseased synovial membrane from a joint which is the seat of an inflammatory reaction. The operation is applicable to any of the joints of the extremities, but its use, perhaps unfortunately, has largely been limited to the knee. The purpose of the operation is to improve the integrity of a joint when there is reason to suppose that the continued presence of synovial inflammatory changes will add to the damage, or when it seems likely that the operation will increase the function of a joint and favorably influence the patient's general health.

The author's original paper demonstrated the feasibility of removing large amounts of synovial tissue, without operative complications or unfortunate later effects, in a series of fifteen synovectomies performed on eight patients with chronic atrophic arthritis. From clinical observation it was evident that the operation was followed by a restoration of the synovial tissue or by the development of a substitute which was functionally satisfactory. No one really knew what happened after the operation until Key made his brilliant report in 1925. He operated upon thirty-five rabbits and in each case removed the entire synovial membrane from the anterior compartment, including the infrapatellar fat pad and a part of the internal semilunar cartilage. He was able to study twenty-four of these joints at varying postoperative periods and he found that the joint was approximately normal after sixty days. The new membrane had a more irregular fibrous groundwork than the original and was deficient in the subsynovial areolar tissue. This study of Key's was so comprehensively carried out and so thoroughly reported as to provide assurance that synovectomy can be done with confidence that restitution of a serviceable membrane will promptly follow.

A great deal of interest in arthritis has been manifested during the past fifteen years and this has been reflected in an enormous output of literature. Unfortunately much still remains to be learned in spite of important advances along many lines. As recently as January 1936 a committee reviewing "The Present Status of The Problem of 'Rheumatism' and Arthritis"[7] examined the American and English literature for 1934, a monumental task involving several hundred separate titles, and gave the following conclusions on etiology and pathogenesis: "From this mass of confusing, sometimes conflicting, data one cannot as yet form any conclusive ideas on the etiology and pathogenesis of the disease. It is obvious that no evidence has been brought forth to change the statement of the American Committee for the Control of Rheumatism, that to date

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

no one etiological factor, no single infection, dietary abnormality, or metabolic derangement has been conclusively shown to be the prime cause of the disease."

In the light of this pronouncement we return to the theoretical considerations upon which the operation of synovectomy was originally applied to chronic atrophic arthritis:

1. The first consideration was the possibility of promoting the resumption of joint function by the operative removal of the organized inflammatory exudate and the possibility of preventing such further joint damage as would result from the continued presence of unabsorbed exudate. The validity of this theory has been established by practical application at the hands of many surgeons, both in the United States and abroad. The theory has also been sustained by the brilliant pathological studies of Nichols and Richardson. Nearly thirty years ago these advanced students published their findings and conclusions. They showed that primary proliferation of the synovial membrane constitutes the first change in the atrophic type of arthritis. This proliferation of the synovia causes a layer of granulation tissue to extend in the form of a pannus more or less completely over the joint cartilage. This granulation tissue, if it comes directly in contact with the cartilage, causes destruction and absorption of the cartilage. The perichondrium may begin to proliferate simultaneously with the synovia and, if and when it does, there is induced the formation of a layer of special connective tissue, of cartilage, or even of bone. From this it appears to be clear that there is a type of atrophic arthritis in which the proliferative process is confined to the synovia, and it is in this type that it is reasonable to expect the greatest benefit from synovectomy. Such benefit may have the dual nature of improving the immediate mechanics of the joint and of preventing the destruction and absorption of the cartilage by pannus pressure.

2. The second original consideration concerned the possibility of assisting the local and general recovery by eliminating the metastatic foci of infection in the joints themselves. Subsequent work on arthritis does not provide a sufficient basis for supposing that the synovial membrane is the site of actual bacterial invasion in chronic atrophic arthritis. While the actual dynamics of the relationship between distant foci and the joints remains hazy, this theoretical consideration ought not to be stressed.

3. The third theoretical consideration for recommending synovectomy was based on the stimulation of the metabolism and the decrease in the suboxidation processes with lowered sugar tolerance which Pemberton had found to accompany arthritis, improvement in which might be expected to follow the restoration of joint function. To the extent that these subversive chemical states are influential in the continuation of the disease, the benefits of synovectomy may reasonably be expected to follow.

Therefore, of the three theoretical considerations which originally led up to this operation, the first and third still seem to be valid, while the second must be abandoned in the present state of our knowledge.

In addition, it is manifest that other and more subtle, though no less effective, benefits may be counted upon to take place as the consequence of better joint mechanics. There can be no doubt that the emotional state has a profound influence upon somatic conditions. Thus the feeling of courage, of confidence, and of increasing well-being that comes with lessened pain and disability reduces the emotional discontent that accompanies pain and crippling lameness. The importance of these factors can hardly be overestimated and it is likely that they constitute fundamental reasons for synovectomy.

The indications for synovectomy cannot be given categorically and they should not be dogmatically stated. It is possible to set forth only the broad outlines and, for the present at least, the decision in a given case should be made by surgeons of broad experience who alone are capable of wise opinion based on a well-rounded view of all the basic considerations. The original purpose of the operation was directed toward the treatment of chronic atrophic arthritis on the grounds already outlined, and the validity of these considerations appears to be substantiated by the author's subsequent experience, as well as by the reports of others. Thus, in 1929, Allison and Coonse, in an analysis of fifty cases of chronic infectious arthritis operated upon between 1923 and 1928, reported that 90 per cent. of these patients were relieved of pain and 65 per cent. showed marked general improvement. They expressed the opinion that a synovial membrane which shows signs of subacute synovitis —local tenderness, pain on motion, and stiffness of the joint—and excess of synovial fluid is the type for which synovectomy is indicated. It is gratifying that these writers added that, while synovectomy is most frequently performed on the knee, it may be used with effect on other joints especially in multiple arthritis.

It is interesting to compare these remarks with what was said by the author in 1922: "Apparently the operation is most likely to succeed if it is done in the type of case or at the stage of the disease where the damage is entirely synovial, the effusion extensive, and the cartilages are not ulcerated." In connection with the type of case or the stage of the disease, it is important to refer to the pathology as pictured by Nichols and Richardson. It will be remembered that they described two types of proliferative arthritis,—in one the proliferative process was confined to the synovia and in the other there was a simultaneous proliferation in the perichondrium. It is logical to believe that the operation will be most helpful when it is applied to the cases in which the proliferative process is confined to the synovia. The difficulty lies in our inability always to distinguish these two types during the early stages of the disease, but it may be hoped that an increasing awareness of the necessity for this differentiation will lead to a greater skill in roentgenographic interpretation, which will aid us in making this distinction.

With regard to further indications for or against synovectomy in chronic atrophic arthritis, it hardly seems necessary to add that the

general condition of the patient is of primary importance. The operation, therefore, should not be attempted in debilitated, actively febrile patients, or in those with profound organic disease which is likely to be aggravated by extensive surgery. In the same way, operations should be guardedly advocated in delicate, sensitive people and in those of poor emotional stability when there is reason to suppose that neither the idea nor the accomplished fact will be well borne. This being a purely elective operation, one should avoid every risk of thereby increasing the patient's burdens. Obviously there is no point in doing a synovectomy when the proliferation has progressed to the extent of severe cartilaginous ulceration and absorption as shown in the roentgenogram by a material reduction in the joint space. After so much damage has occurred, it is impossible to improve the mechanics of a joint by a synovectomy. It should be constantly remembered that the great purpose of synovectomy is to prevent extensive joint damage, and to this end the operation must be done early or at such time as it becomes clear that the process is not receding, that the exudate is too slowly resolving, or that proliferation continues in spite of all other therapeutic aids.

During the past fifteen years many surgeons have advocated the use of synovectomy in forms of arthritis other than the atrophic variety. J. S. Speed recommended the operation for traumatic arthritis, benign tumor of the knee joint, osteochondromatosis, and syphilitic synovitis. Bernstein added to this list hypertrophic arthritis, and Heyman qualified its use in this type by advising it in the presence of joint mice if secondary synovial changes occur. Skillern reported a good result from synovectomy in a case of hypertrophic villous arthritis accompanied by a well-marked osteo-arthritis. Krida reported the benefits resulting from synovectomy in two cases of intermittent hydrarthrosis of the knee joint. Besides these definitely specified types of lesion for which synovectomy has been advised, it is well known that many surgeons have applied it to the treatment of joint tuberculosis. It is desirable to examine critically these newer recommendations and to evaluate their probable usefulness on the basis of the theoretical grounds and the clinical results.

Several writers have concurred in Speed's advocacy of synovectomy for traumatic arthritis, and it is gratifying to observe that complete recovery has been the rule in all of these cases thus far reported. On theoretical grounds it appears to be logical to expect recovery following the removal of chronically inflamed synovial tissue which is swollen, oedematous, wrinkled into folds, and covered with hypertrophied villi and fatty tabs. Such a membrane has largely lost its functional capacity and, since in the purely traumatic type there is no contributing cause of constitutional origin, its removal ought to be followed by recovery. The clinical results thus far reported certainly bear out these ideas, and it may, therefore, be confidently said that chronic traumatic arthritis provides one of the major indications for synovectomy.

Benign tumor of the knee joint has been listed by several writers as a

proper indication for synovectomy and there would seem to be every reason for concurring in the self-evident rationale of this procedure. The author's own experience in this respect is too limited for a guide, and there is very little actual clinical material of this type in the literature.

Syphilitic synovitis is a condition in which synovectomy results in great benefit. Here is a chronic process constantly kept active by the parasites until grave destruction results in the joint. The removal of this diseased tissue and the simultaneous use of antisyphilitic treatment may be relied upon to terminate the process and to prevent its recurrence. Relapse may be expected, however, if the accompanying antisyphilitic treatment is inadequate in amount or is discontinued too soon. The writer's experience with this condition has been limited to cases of syphilitic arthritis of hereditary type.

The indications for synovectomy in chronic hypertrophic arthritis never have been clear to the author, and the literature does not satisfactorily set them forth. It would appear that little benefit could be expected in the ordinary cases of hypertrophic arthritis in which the process usually is confined to the articular margins where it seems to originate. In this disease it is difficult to conceive that synovial changes occur except as secondary effects, and, since hypertrophic arthritis is essentially a disease of middle or old age, the patients as a class are not generally suitable operative candidates. The writer has never encountered an example of hypertrophic arthritis that seemed to him to present the appropriate indications for synovectomy. This should not be taken as a dogmatic statement, but it does suggest that the patient should be very carefully examined and that one ought to be quite certain that there is present a sufficient degree of synovial involvement to warrant the belief that interference with it is justified. As Heyman has said, synovectomy may be helpful in hypertrophic arthritis with joint mice if secondary synovial changes occur.

In intermittent hydrarthrosis, as Krida has so well shown, there is every reason for resorting to synovectomy. In this disease the etiology is obscure, the prognosis is poor, and the process seems to center in the synovia. Under these circumstances, the operation is logically applicable, because it deals with the joint tissue primarily involved and, once the diseased membrane is removed, there is reason to expect that the new synovia may not be attacked by the same remote or local cause. Both from theoretical considerations and from the good results reported, it is reasonable to accept intermittent hydrarthrosis as an indication for synovectomy.

The temptation to do a synovectomy in tuberculous synovitis is strong, and it is easy to understand why a surgeon's hope that he may obviate the necessity for a resection or an arthrodesis can help to persuade him that it ought to be tried. Unfortunately, the abstract considerations are against this, because it would seem to be necessary to remove all of the infected tissues, and, as this is practically impossible, relapse is likely.

The literature throws only a faint light on this subject, and in the few cases in which the author has tried this operation recurrences made it necessary later to do an arthrodesis. Barthélemy has reported two cases in detail and says that the operation is justified in certain cases, the most favorable type being synovitis with rice bodies of slow chronic nature, without temperature or crises of pain, and in a patient, preferably young, without other tuberculous lesions. Very recently Campbell has laid down the guiding principles for synovectomy in these words: "The type of joint in which the procedure is especially indicated is one in which there is extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent joint fluid. Such a joint may be caused by low-grade infection, osteochondromatosis, traumatic arthritis, benign tumors, and *synovial tuberculosis.*" So far as can be ascertained from the literature, it is apparent that some surgeons believe that there is a field of usefulness for synovectomy in tuberculosis of the synovia, and it is, therefore, not reasonable that the author's unsatisfactory experience should be accepted as a basis for entirely closing this door.

In addition to these conditions for which synovectomy has been advised by various authorities, the writer wishes to add two more types of synovial disease to the list. One of these is a form of chronic synovitis caused by local foreign-body irritation, and the other is a form of synovitis accompanied by an infiltration of the synovia by bone. Both of these conditions were encountered because confidence in the operation suggested its employment in these obscure cases although the usual clinical signs were not present.

Extended comment in regard to the foreign-body type of chronic synovitis is unnecessary. In this particular instance a sliver of wood had been lying free within the knee joint for a long period. The synovia presented the characteristic changes of swelling, oedema, and chronic inflammation, and there were numerous masses of free fibrin, in one of which the wooden splinter was found. The free masses were removed, and a conservative synovectomy was done.

The writer has never heard the term "synovitis ossificans", but the appearance of the synovial membrane in the second case, both in the roentgenogram and at operation, indicated that it was extensively infiltrated with actual bone. The disease appeared to follow a mild acute traumatic synovitis, and the process developed very slowly during a period of two years. The patient was a healthy young woman, and no cause was found except the trauma. The operation was made difficult by the density of the synovia. The patient made a complete recovery. The sections showed the calcific material to be actual bone. The pathological report follows:

"*Macroscopic Examination:* Several ragged pieces of synovial tissue are quite dense and show calcific changes in focal areas. Together they are six centimeters in diameter.

"*Microscopic Examination:* Sections show synovial membrane in which there are irregular areas of bone and cartilage formation. These appear to be actually heterotopic

bone. There is a moderate chronic inflammatory reaction with considerable fibrosis. There are no granulomata.

"*Pathological Diagnosis:* Chronic ossifying synovitis."

Goldthwait mentions that in one of his early cases "a calcareous degeneration was found, and in the membrane there were numerous calcareous bodies, varying in size from the head of a pin to a good-sized pea, which, on section, showed true cartilage and bone cells".

The technique of synovectomy presents certain important features which ought to be constantly kept in mind. The first of these relates to its usefulness in any of the joints of the extremities. The customary attitude that the operation is confined to the knee joint is unfortunate. Excellent results have been obtained in the wrists, the elbow, the ankle, the interphalangeal and acromioclavicular joints, and the sternoclavicular joint. In fact, it is in some of these smaller joints that the end results have been most successful, and it is quite a satisfaction to the author that the first synovectomy which he did was in the metacarpophalangeal joint of a thumb, and this was in 1911. The patient, suffering at the time from an atrophic arthritis, was seen fifteen years later, at which time the operated joint had good function.

The approach to a joint for the purpose of synovectomy should be through the extensor surface in all instances, usually by way of a longitudinal incision. A single incision is preferable; multiple incisions are to be avoided unless there are special indications for them. The split patellar incision for the knee offers no material advantage over the median incision along the quadriceps tendon, the inner border of the patella, and the patellar tendon.

The extent of the synovial removal is a difficult matter to outline. The object is to do as little as will assure the needed benefits. It seems to be a mistake to do a complete synovectomy of the anterior or extensor compartments in every instance. It is assumed that no one tries to be so thorough as to attempt both the extensor and the flexor sides at once. Rarely may it be necessary to attack the flexor aspect of the knee when a communicating popliteal bursa is especially involved. Naturally, in tuberculosis the dissection should be as complete as possible and perhaps, too, in benign tumors and in syphilis, but in atrophic, hypertrophic, and traumatic arthritis it is probable that the best results are achieved by restricting the procedure to the most extensively involved portions. In other words, a complete block dissection is not always needed, and in atrophic arthritis especially the writer is inclined to believe that the full benefits and a lessening in the risk of postoperative fibrosis follow the removal of sections at intervals. After all, the improvement in the local circulation from this procedure may reasonably be expected to promote the resolution of the less organized exudate. Apparently this occurs in those cases in which only the extensor portion of the synovia is operated upon and improvement follows in the flexor portions.

Hard and fast rules concerning postoperative drainage and im-

mobilization ought to be avoided. The type of patient, the character of the lesion, and the customary practices of the surgeon are the proper guides in these matters. It is important to note that synovectomy is not calculated to correct joint deformity except to overcome mild flexion by increasing the joint space.

Considerable question has been raised concerning the method of dealing with the menisci. This matter can be determined by the application of general principles, and, if the menisci obviously are not involved in the proliferative process and are not themselves the seat of a traumatic, inflammatory, or degenerative lesion, it is best to leave them alone. An exception to this rule may be made in cases in which their removal will greatly increase joint space and make it easier to overcome flexion.

SUMMARY

The history of synovectomy shows that this procedure has had a gradual growth over a period of fifty years and that many surgeons in different countries have contributed to its evolutionary development.

Judging from the author's personal experience and the extensive literature of the past fifteen years, the operation seems to have established for itself a field of usefulness in various kinds of joint disease.

The consensus of opinion is that synovectomy may well be employed in a joint in which extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent increase of joint fluid are present. Such a joint may be caused by:

1. Chronic atrophic arthritis
2. Traumatic arthritis
3. Benign tumors
4. Osteochondromatosis
5. Syphilitic arthritis
6. Intermittent hydrarthrosis
7. Synovitis ossificans
8. Hypertrophic arthritis
9. Synovial tuberculosis
10. Synovitis caused by foreign-body irritation.

Theoretical grounds appear to exist for reliance upon synovectomy as a preventive of joint deformity, but it is not intended as an operation to correct deformity.

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THE EVOLUTION OF THE KNEE JOINT *

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The knee joint is the largest joint in the body and the most vulnerable one. It is more complex than most joints. The semilunar cartilages, the cruciate ligaments, the large synovial membrane, and the overlying patella are all structures designed for protection and stability, and yet each of these is a frequent source of knee pathology.

In order to learn more of the function of these various structures found in the human knee joint and to discover, if possible, their origin, the knees of a series of animals were dissected and studied. Animals were selected according to their phylogenetic development in the main line of ascent from amphibians to primates.

Before describing the details of the knee joints of these animals, it would seem helpful to review briefly the history of the locomotor system. This will show us how environmental changes made necessary the many modifications and adaptations of these joints and will lead us to a better understanding of the relationship between present-day environment, morphology, and pathology.

Originally all animals, including vertebrates, lived exclusively in the water and moved by sending waves of contraction along the muscular segments of their bodies. Fins were projections of the skin or body wall and functioned in maintaining balance and steering the tapered bodies.

As water became shallower in some areas, certain fishes adapted themselves to swamp life, breathing air and using fins as paddles and then as limbs to crawl along the muddy banks. In search of food they climbed higher and higher, and after many millions of years gradually developed limbs like turtles and lizards that raised their bellies off the ground. The higher they climbed, the longer their limbs grew and the more complicated became their joints. Eventually they learned how to run along the ground very swiftly and to climb trees and to swing from branch to branch. Swamps, jungles, forests, deserts, prairies, mesas, mountains, and climatic changes necessitated modifications and adaptations of limb and body. As nature worked out some marked improvement, this device would be bequeathed to many diversified descendants. Thus the bodies of the more recently evolved animals came to have many structures—most of them of utmost importance, some of doubtful value—inherited through the will of bountiful nature from myriads of ancestors who fought a life-and-death struggle to acquire them.

The simplest present-day vertebrate having a knee joint is the amphibian, of which the *salamander* is a good example. This animal has a long

* Read before the Jacobi Medical Society, Washington, D. C., in March 1937, and the Orthopaedic Section of the New York Academy of Medicine, New York, N. Y., in May 1937.

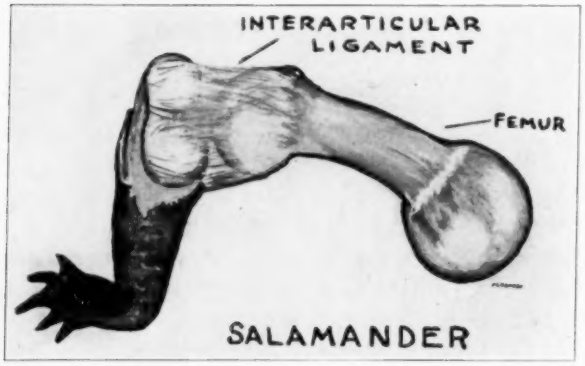

FIG. 1

reptilian body with very small limbs. The knee joint consists of the round condyles of the femur and the single tibiofibula with a simple thin interarticular membrane which is probably a synovial lining. No menisci nor cruciate ligaments are to be made out. There is no patella, the extensor muscles ending in a ligament which passes over the joint to insert in the shin bone.

The *frog* has very long hind limbs capable of considerable activity. The knee joint is not unlike that of the salamander just described except that the interarticular membrane when stretched out presents two crescentic thickenings suggestive of menisci. There is no cartilage in this membrane even where the thickenings occur. It is rather remarkable that this is the first indication of the morphology which in the more highly developed animals will shape the semilunar cartilages. No patella is present.

The reptilia show considerable advance in the development of the limbs and especially of the knee joint. The *alligator* which was dissected has two bones,—a tibia and a fibula. The condyles of the femur are more pronounced, so as to give a pulley-shaped appearance. The upper end of the fibula is enlarged and prolonged, so as to articulate with the lateral tuberosity of the femur. Definite cartilaginous menisci are present and seem to arise from the transverse ligaments of the joint. The lateral meniscus has a secondary cartilaginous ring which is attached to

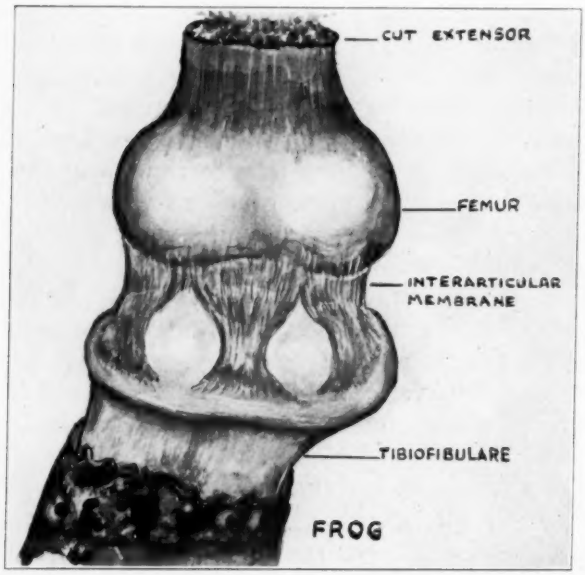

FIG. 2

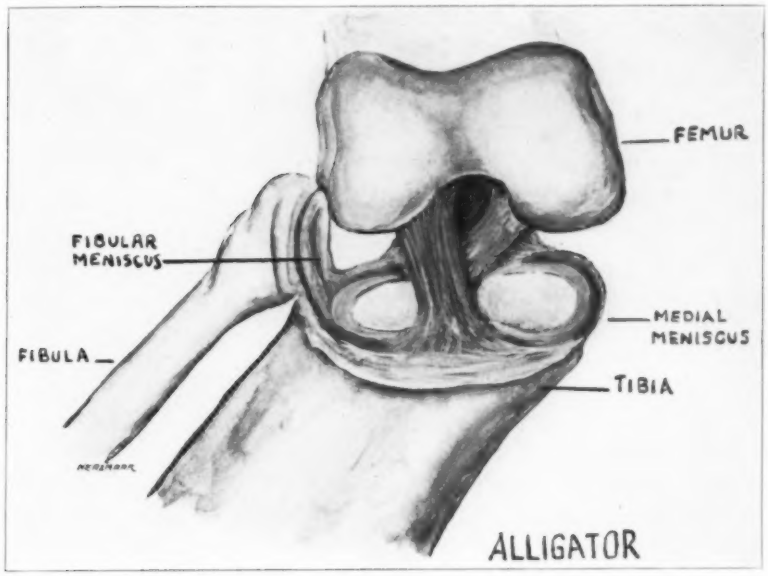

FIG. 3

its lateral border and is at right angles to it, so as to be interposed between the fibula and the lateral surface of the femur with which it articulates. A thin synovial membrane could be made out, but no patella.

The mammals have come a long way since their remote ancestors crawled about the slimy banks of their primeval swamps. One of the best examples of the simpler mammals is the *opossum*. This animal is a marsupial, has well-developed limbs, and can move quite rapidly. The knee joint shows the femoral condyles with a marked groove between them. The tibia has a sloping surface which extends anteriorly from the joint. The ligamentous termination of the extensor muscles of the thigh has a ligament which branches off at right angles to it to insert into the upper border of the sloping surface of the tibia, while the overlying tendon inserts into the lower border of the oblique surface of the tibia. There is no patella, but the extensor tendon is thickened over the joint line to form a rudimentary patella. There are two very well-developed

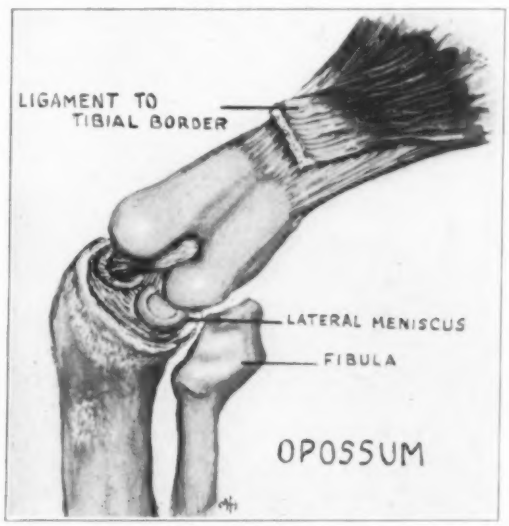

FIG. 4

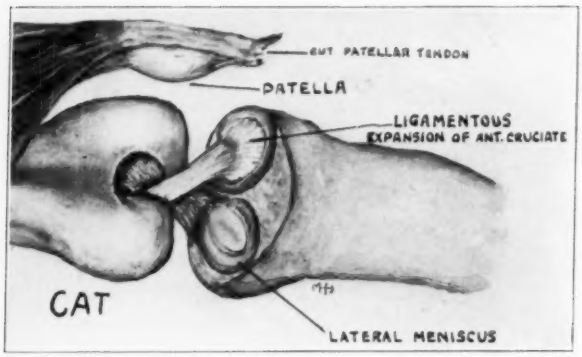

FIG. 5

semilunar cartilages. The lateral meniscus has a prolongation posteriorly which corresponds to the posterior cruciate ligament. The ligamentum mucosum is well developed and inserts into the tibia between the two menisci. The head of the fibula is enlarged and extends above the joint line to the lateral condyle of the femur, but no intra-articular cartilage is seen as in the alligator.

The line of ascent now brings us to the placentalia, of which an excellent example is the *cat*. The limbs are muscular, and the joints are designed for efficient function under strenuous conditions. A well-developed patella is observed with its patellar tendon inserted into the tibia well below the joint line. A ligamentous band runs off beneath this tendon to attach to the transverse ligament. The condyles are well developed and a deep groove lies between them, which always indicates speedy locomotion. The medial meniscus is a narrow band of fibrocartilage, formed by a thickening of the coronary ligament, and is attached at the medial border to the expansion of the anterior cruciate ligament. This expansion of the anterior cruciate ligament spreads out as a thin membrane to cover the entire medial tuberosity, disappearing under the free edge of the medial meniscus. The posterior cruciate ligament inserts by two branches into the posterior edge of the tibia, but does not spread over the cartilaginous surface of the lateral tuberosity. The head of the fibula is small and articulates with the tibia only.

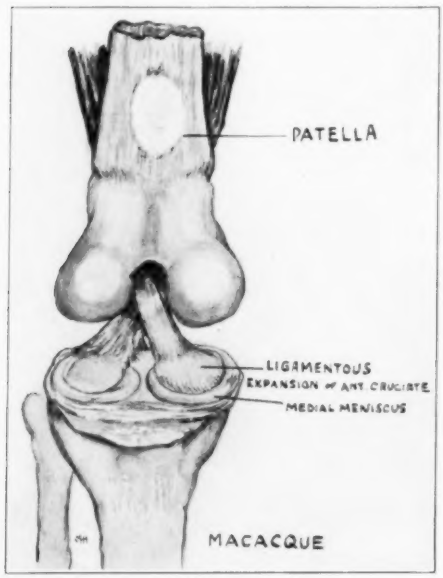

FIG. 6

The highest development in the animal kingdom is attained by the primates. These are the monkeys whose limbs are well adapted to strenuous running, climbing, jumping, and swinging.

As an example of the more primitive of this group, the knee of a *macaque* was studied. This

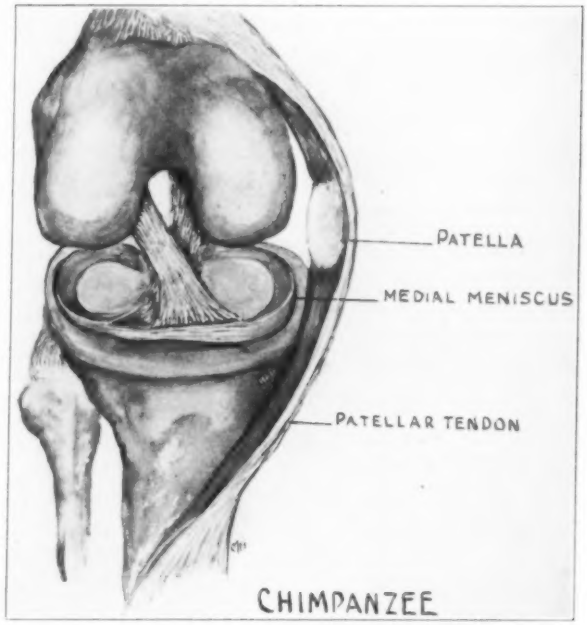

FIG. 7

animal has no prehensile tail, but its legs have an opposable hallux which makes the foot a grasping organ. The knee joint is well developed. The patella and patellar tendon are closely bound over the joint, allowing very slight excursion of the bone. The medial meniscus arises from the coronary ligament and extends only as a narrow circular rim around the tibial tuberosity. The anterior cruciate ligament is quite large and as it reaches the tibia it expands into a ligamentous membrane, covering over the entire medial articular surface of the tibia and disappearing under the free edge of the meniscus. The posterior cruciate ligament becomes attached to the lateral meniscus which is also very narrow and circular. The cruciate ligaments would seem to provide extra stability to the joint when greatly flexed, as well as when extended under traction as when the animal swings from a branch. The narrow menisci would appear to allow for rotation with little danger of tearing the interior thinned-out portion, as found in the human knee.

The simians are the most highly developed of the primates and the remarkable resemblance of the body structure to that of the human being is well known. The knee of a *chimpanzee* was dissected and studied with reference to the habits of the animal. This monkey assumes a partly erect posture, but helps to support its body with the forelimbs, using the backs of the phalanges for this purpose. The knee joint is held in a habitually flexed attitude, and the muscles are very well developed, the muscle tissue extending well down to the joint line. On dissecting the joint, it is seen that the rather small patella is tightly bound down over the joint by a strong patellar tendon. This allows for very slight excursion of the patella. The condyles are well developed, and the groove between them is much less pronounced than in the macaque. The cruciate ligaments are unusually large in proportion to the joint, but they do not expand over the articular surface as in the cat or the macaque. The menisci are crescentic and are more nearly like that of the human being but very narrow. The closely knit construction of the joint makes it

remarkably well adapted for the strenuous work which it must do in primitive life.

EMBRYOLOGY

In tracing the evolution of the limbs, and especially of the knee, from the lowest vertebrates it is remarkably evident that, despite tremendous changes in other organs of the body, man has retained a great deal of the primitive features of the limbs. The bones of the legs of most mammals became greatly modified—for instance, the comparative elongation of the legs in horses and the disappearance of limbs altogether in whales—whereas in man, despite modification for plantigrade life, the original plan of structure is still clearly apparent.

Thus, in accordance with the biogenetic law or recapitulation theory, we should see the development of the limbs through the evolutionary stages in the embryo of man. At the end of the fourth week an elongated ridgelike elevation is seen on the dorsal border of the embryonic body. The limb buds arise from this ridge. It is held that this lateral ridge represents a row of fins and the limbs are specialized fin rays. These buds grow and extensions grow into them from the muscle plate and skin plate of each of the segments opposite the origin of the bud, and a nerve process from each of the corresponding segments of the spinal cord is sent into this mass. This segmental origin is seen only in the lower vertebrates and is inferred for the higher vertebrates.

By the seventh week the cartilage centers have appeared for the majority of the bones of the lower extremity. In the earliest stages the limb buds are so placed that the lower limb is rotated outward, while the upper limb is rotated inward. This is a position normally found in the primitive amphibians. This period, reached about the second month, may be called the reptilian stage.

Further development takes place, so that the cartilaginous skeleton gradually shows centers of ossification as the limbs elongate.

The knee joint up to the second month is a dense mass of tissue. The joint is flexed at nearly a right angle. The limb bones are formed from a center of chondrification within the unjointed skeletal blastema. At the periphery of these centers growth proceeds most rapidly, so that the centers approach each other, leaving the original blastema between them. This dense tissue or interchondral disc gives rise to the structures within the joint. A membrane called the perichondrium surrounds the growing cartilage and is derived from the peripheral part of the blastema. By the ninth week a joint space forms by the disappearance of the mesenchymal cells, first at the periphery and finally in the center. The perichondrium bridges across the limb segments to become transformed into a capsular ligament. In front of the joint this becomes denser to form the quadriceps tendon. The capsule now becomes lined with cells of the perichondrium to form the synovial membrane. The cartilaginous origin of this membrane is shown in certain pathological conditions in the adult

whereby synovial villi give rise to cartilaginous nodules. Remnants of the interchondral plate project into the gap between the articular margins to form the menisci.

The thickening of certain parts of the capsule depends upon the strains to which the joint is subjected. The front portion was described as early showing strength to form the quadriceps tendon. Later the posterior portion becomes strengthened to prevent overextension. In man the condyles of the femur developed toward the popliteal space, thus isolating a part of the posterior capsule which remains within the joint and forms the cruciate ligaments.

We have seen how the reptilian knee joint revealed three menisci, due to the articulation of the fibula with the femur. Eventually, in the progress of evolution, the fibula became excluded from the joint and the fibulofemoral disc was included in the tendon of the popliteus.

In the embryo the upper end of the fibula is being excluded from the knee joint about the eighth week. At this stage there are five synovial cavities in this joint,—one between the patella and the femur, two between the femoral condyles and the primitive menisci, and two between the upper surface of the tibia and the menisci. About the fourth month these cavities become continuous, leaving the primary septa as the cruciate ligaments.

The circular form of the lateral meniscus and its continuity with the posterior cruciate ligament seen in the macaque are features in a knee joint where the power of rotation is highly developed. The menisci of the human embryo lose this circular form and the cruciate ligaments are only partly attached to them.

THE FUNCTION OF THE KNEE JOINT

From a consideration of the comparative anatomy, one may determine the function of the various structures which make up the joint.

Man is the only animal to assume the completely erect posture, and the knee joint is completely extended while bearing the weight of the body. The condyles of both the femur and the tibia find their largest development in the human knee joint. This affords extra surface for weight-bearing and adds to stability. The patella, which in the lower animals is rather poorly developed and has a very limited excursion, is in the human knee much larger and thicker and moves into a position directly above the joint line when the knee is fully extended. The increased thickness of the patella carries the patellar tendon more anteriorly and thus increases the tension on the quadriceps. This principle is used in the violin to increase the tension of the strings, the bridge corresponding to the patella.

The cruciate ligaments have been a subject of considerable controversy as to their importance in joint stability. Many methods for their repair have been devised in the belief that they are necessary in the proper function of the joint. In the animals dissected the cruciate ligaments

were relatively much larger than those normally found in the human joint. In the cat and the macaque the cruciate ligaments expanded to cover the entire surface of the tibial condyle and were better developed than in any of the other animals. The tree-climbing, limb-swinging habits of these animals would induce us to believe that the cruciate ligaments act as check ligaments against rotation and subluxation when the knee is flexed.

The relatively small size of the cruciate ligaments in man would lead us to suppose that they are vestigial and relatively unimportant in knee stability. Embryological studies would tend to confirm this, as the cruciate ligaments were part of the posterior capsule and became isolated within the joint as the femoral condyles increased in size posteriorly.

The menisci are proportionately much larger in the human knee joint than in any of the animals dissected. The best development of these fibrocartilages in the animals was seen in the chimpanzee which assumes a semi-erect posture in walking.

These menisci are even better developed in the human knee which bears weight in the fully extended position. The value of these structures can be determined from a study of their function. In the extended position they fill in the space around the condyles and deepen the articular surfaces of the tibial condyles, thus adding stability. By this accurate approximation of the articular surface, a film of synovial fluid is spread to lubricate the cartilaginous surfaces. They act as shock absorbers where sudden strain is transmitted to the hyaline cartilaginous surfaces. Being of fibrocartilaginous structure rather than true hyaline cartilage, they have more power of growth and healing when injured.

In the small animals with knees habitually flexed, the menisci were small and very narrow. The alligator showed well-developed menisci, but this animal is relatively heavy and has a fibula which articulates with the lateral surface of the femoral condyle.

These findings would cause us to feel that the menisci are very important structures for weight-bearing knees.

Since the menisci are of fibrocartilaginous tissue and will regenerate if the synovial attachment is left intact, it would seem desirable when meniscectomy is indicated to remove only the torn portion, leaving a rim of meniscus attached to the synovia.

SPINAL FIXATION

A Method of Bending the Graft

BY GAWAD HAMADA, M.R.C.S., ALEXANDRIA, EGYPT

From the Government Hospital, Alexandria

The conservative methods of fixation of the spine require a long period of recumbency, which is trying to the patient, and the end results are not as good as those obtained by the operative methods. It has been the experience of many writers that the percentage of solid union and healing of the vertebrae is greater and the mortality is less when operative measures are employed than when the treatment is conservative.

The aim of any operative method of internal fixation of the spine is to shorten the period of recumbency and external immobilization. The procedures most frequently employed are those of Albee and Hibbs and what may be termed the "modified method". The author wishes to discuss the relative merits of these three techniques and to present a method of bending the tibial graft, which he has used with success.

THE ALBEE OPERATION

The author feels that this method has the following disadvantages:

1. The graft is too superficial.
2. The entire surface of the graft is not apposed to the vertebrae; it bridges the spines.
3. The vascularization of the graft is not as good as that afforded by the Hibbs or modified methods.
4. The graft is away from the center of motion of the vertebrae and is, therefore, liable to tension and resultant fracture.

THE HIBBS OPERATION

This method presents the following difficulties:

1. The operation is long, tedious, and not without risk.
2. If the operation is not thoroughly and painstakingly carried out, it usually results in failure.
3. If the operation fails, there is not much possibility of performing another.
4. The cutting of the interspinous ligaments tends to weaken the natural support of the vertebral column, should the operation be unsuccessful.
5. If sepsis should develop, there is great danger of sequestration of the sections of the vertebrae which have been turned up and down.

THE MODIFIED METHOD

Although this technique has been fully described by Sir William I. deC. Wheeler [1], the author feels that it has not received the attention which it deserves, and, therefore, a brief description is included.

FIG. 1

Graft in different positions.

After deep incision of the aponeurosis, the erector spinae muscles are detached, the laminae are exposed, and the bone is scraped clean of any adherent muscle tissue. The compact layer of bone is also shaved off at this time. The graft is then laid in the junction of the bases of the vertebral spines and the laminae, the cancellous portion of the graft being apposed to the freshened bone.

The author feels that this operation is more efficient than the other two for the following reasons:

1. It is very simple and, with the aid of an electric saw and good assistance, requires from twenty to thirty minutes.

2. The graft is placed deeply, is well covered by the erector spinae muscles, and has a large area of contact with the vertebrae, thus affording a better opportunity for vascularization.

3. If sepsis should develop, causing the graft to sequestrate, a second operation can be done on the other side of the spine.

4. The gibbosity is less pronounced on the laminae than at the spines where a greater degree of bending of the graft is needed.

5. The fusion is near the center of motion of the vertebrae and there is less danger of fracture.

FIG. 2

Spine with graft in position adapted to the curve.

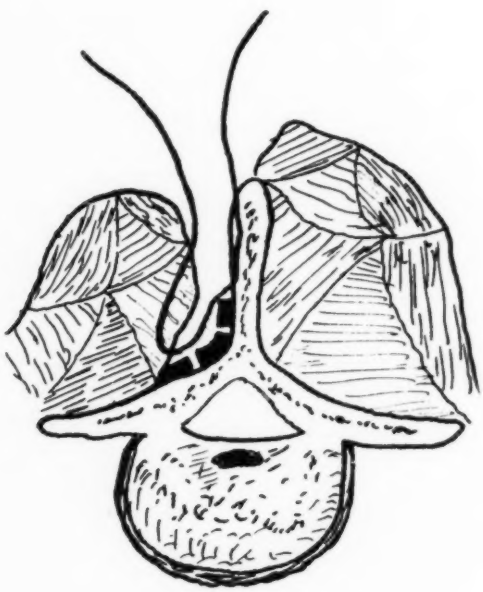

FIG. 3

Graft in position after suturing.

METHOD OF BENDING THE TIBIAL GRAFT

The author has found in many cases that a flexible graft is advisable or even necessary. There are several methods of bending the tibial graft to make it fit the kyphotic or scoliotic spine, but nearly all are unsatisfactory. The writer has found that the best way of making a graft pliable is to slice it into several portions and to leave it attached at its base.

The outline of the graft is marked with a knife and, with an electric saw, the longitudinal cuts are made. The graft is then marked into from three to five sections, depending on the size of the graft. These sections are carefully cut to within two inches of the base. Transverse cuts are then made, and the graft is gently disengaged with a knife and removed. It will be seen that the graft is in the shape of a comb, and the divided portions are easily bent. The graft is placed under the erector spinae muscles, and the deep layer of the interspinous ligaments is sutured to the deep layer of the muscles, the stitches being taken quite close together. As the suturing progresses upward, the graft bends and fits snugly over any marked gibbosity.

The author is indebted to Dr. Sorour of the Government Hospital for the drawings which accompany this paper.

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INTRACAPSULAR FRACTURE OF THE NECK OF THE FEMUR

Case Report and Pathological Study

BY LAURENCE JONES, M.D., AND B. ALBERT LIEBERMAN, JR., M.D.,
KANSAS CITY, MISSOURI

Fractures of the neck of the femur are unique. There is almost general agreement that in such fractures imperfect reduction results in non-union, while in other fractures imperfect reposition is often followed by union. Efforts at better reduction with the aid of the lateral roentgenogram have been rewarded with improvement in end results. Many observers [1, 2, 3] believe that the failure to recognize this fact is the chief cause of disaster.

Speed recently expressed the opinion that there are additional unknown factors when he entitled an address on fractures of this type, "The Unsolved Fracture".

The case which the authors wish to present indicates that sometimes this condition is a pathological fracture, and that the same fault which causes the fracture is the one responsible for delayed healing or even complete non-union. These cases are probably doomed to non-union at the moment of fracture. With our interest directed to this point, additional material is being studied which would tend to confirm this view.

No attempt will be made to discuss the anatomical conditions which favor non-union, as they have been so adequately presented by Phemister and by Santos. The description will be limited to the pathological changes that have been found in patients dying shortly after femoral-neck fractures, and to the inferences that can be drawn from these studies. Although early death after fracture occurs frequently, there are in the literature very few complete pathological descriptions of the fracture site. Both Phemister and Santos have included such a description, and the pathological study here reported was made earlier after the injury than either of theirs.

Phemister reported the case of a female, aged seventy-five, who had fractured the neck of the right femur fifteen days before death. Pathological specimens showed bone necrosis along the fracture line with erosion of the neck well under way. He concluded that "non-union might have been the result but delayed union after more erosion of the neck might have occurred".

Santos reported the pathological findings following a fracture of the neck of the left femur in a man eighty years of age. Death occurred twenty-four days after injury. This case fell into the group of impacted fractures. In spite of close bony apposition, there was considerable necrosis along the line of fracture without any evidence of either fibrous or osseous repair.

CASE REPORT

Mrs. E. D., fifty-two years of age, slipped and fell directly on the lateral aspect of the right thigh on April 16, 1933. Three hours later she was hospitalized and anteroposterior and lateral roentgenograms were made. They showed a comminuted fracture of the right femur with two distinct fracture lines; the shaft lay behind the trochanter. One fracture line involved the base of the neck and the other, the trochanter. (See Figure 1.)

FIG. 1

Anteroposterior roentgenogram showing comminuted fracture through base and neck of trochanter with displacement of fragments.

The patient had suffered three previous fractures,—one of the upper end of the right tibia below the knee in 1902; another of the lower end of the left tibia in 1905; and the third of the upper end of the right humerus in 1923. All of these healed normally and without any residual deformity or permanent limitation of joint motion. The patient had also been treated for diabetes mellitus before the present injury.

Examination revealed the usual findings associated with fractures of the neck of the femur. Because of the diabetic history and shock, reduction was delayed for eight days.

An electrocardiogram was taken during this period and found to be normal. When the patient's temperature dropped from 102 degrees to normal, reduction was advised. Due to comminution and the nature of the displacements, internal fixation was selected. On April 24, 1933, eight days after the injury, under general anaesthesia, the following procedure was instituted: Through a typical Smith-Petersen incision the head and neck of the femur were exposed. Intracapsular and intertrochanteric fractures were visualized. An interlocking metal screw was applied, fixing the head and neck to the trochanter. The wound was closed, and a plaster spica was applied with the right leg abducted and internally rotated. About seven hours later the patient complained of dyspnoea and expired within a few minutes.

An immediate necropsy disclosed a large infected thrombus in the iliac vein near the site of fracture, and the cause of death to have been multiple pulmonary emboli.

The gross specimen of the head and proximal portion of the neck of the femur (Fig. 2) showed a central linear defect, due to the insertion of a bone screw. The remaining portion of the neck was occupied by a large triangular defect marked by a complete absence of endosteum. Only a cortical shell remained in the inferior portion of the neck. This cavity was filled with brownish granular detritus,—bone sand. The cartilage covering the head was smooth and glistening throughout. Small, circular, yellowish areas were scattered throughout the head just below the cortical plate from which sections were obtained, as indicated in Figure 2.

The section shown in Figure 3 revealed normal bone with normal yellow bone mar-

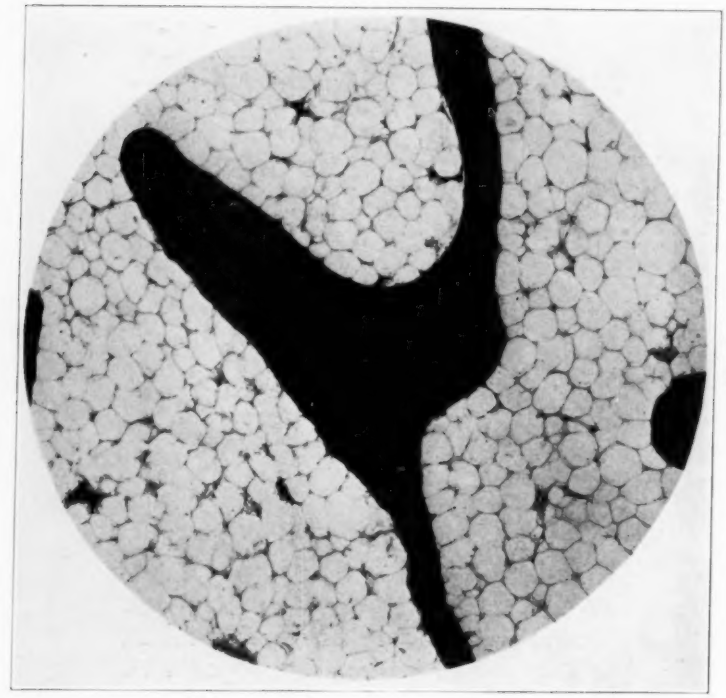

FIG. 3

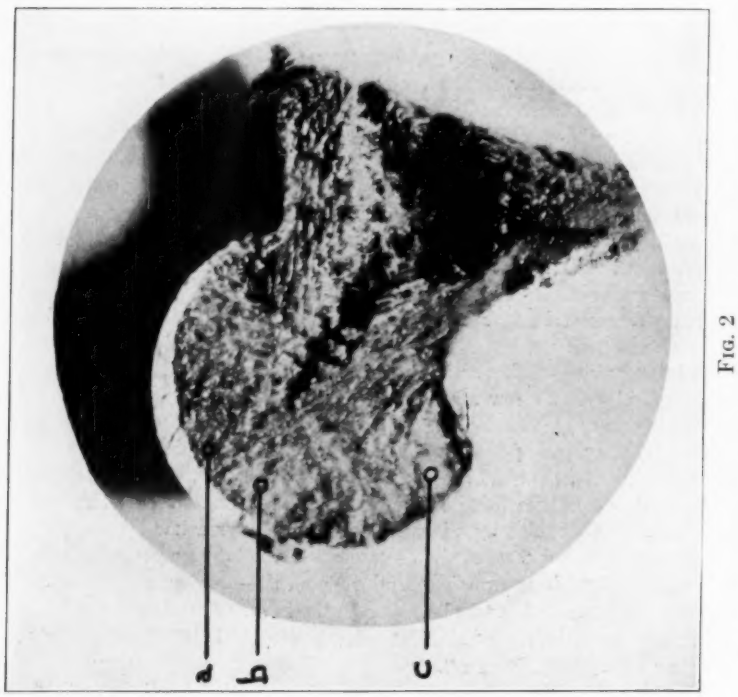

FIG. 2

Fig. 2: Proximal fragment showing head and neck of the femur with extensive endosteal loss in neck and scattered focal necrotic areas in head. The letters *a*, *b*, and *c* indicate the areas from which microscopic sections were taken.

Fig. 3: Photomicrograph showing normal marrow and trabeculae. (See Figure 2, *a*.)

FIG. 5

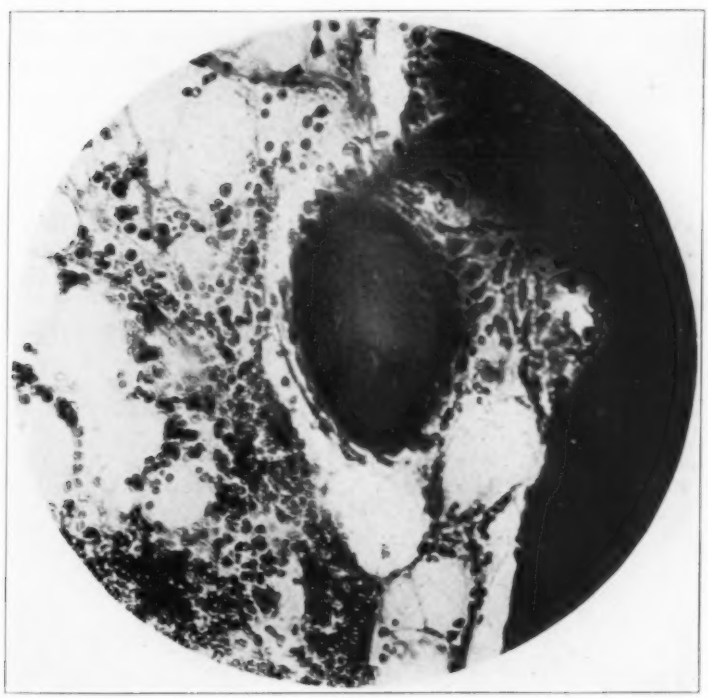

FIG. 4

Fig. 4: Photomicrograph illustrating scattered areas of bone resorption accompanied by extensive alveolar hemorrhage. (See Figure 2, *b*.)
Fig. 5: Photomicrograph illustrating both well-advanced alveolar disintegration and trabecular resorption. (See Figure 2, *c*.)

row. The bone trabeculae were smooth in outline. The alveolar arrangement was undisturbed, and the sole deviation from the normal shown in this specimen consisted of a few scattered areas of hemorrhage evidenced by minute collections of red blood cells.

In the section shown in Figure 4 there was much hemorrhage and round-cell infiltration. The bone trabeculae were hazy in outline and in many places were lined with osteoclasts. Adjoining bone marrow showed some beginning disorganization and was vacuolated in areas.

Figure 5 demonstrates marked disorganization of the fatty alveolar structure. Certain areas are filled with red blood cells. A trabecula with a hazy periphery is shown, and around the tip in the center there are a large number of osteoclasts. Normal bone lamellae are seen in the periphery of the section.

DISCUSSION

On the basis of these findings one may definitely conclude that this case was doomed to non-union as a result of almost complete necrosis of the neck as early as eight days after fracture. The focal necrotic spots in the head show that the blood supply to this area was very deficient and probably would have accelerated bone destruction. This case is presented to emphasize the necessity for extremely accurate reduction in this type of fracture. In this particular instance the result was fore-ordained, regardless of the type of treatment. The wide-spread necrosis in this case may be present in varying degree in all cases. It is this factor which probably puts this lesion in a class by itself. We do not feel that the insertion of the bone screw was responsible for necrosis, as it was *in situ* only a few hours. If, however, this screw acted as a necrotizing agent, then any form of internal fixation in this type of fracture is questionable.

The problem involved in the treatment of this type of fracture is far from settled and further studies of this nature will aid in its solution. It may be that visualization of the fracture site may be necessary before the proper type of treatment can be selected.

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RECONSTRUCTION OPERATIONS FOR OLD UNUNITED FRACTURES OF THE NECK OF THE FEMUR *

BY E. G. BRACKETT, M.D., BOSTON, MASSACHUSETTS

The object of this paper is not to advocate any one method of treatment of old ununited fractures of the neck of the femur, but, rather, to present a few observations on the subject as a whole. The treatment of this condition is a problem for the solution of which a great deal has of late been offered, but it seems that frequently the essential factors have been somewhat overshadowed by the emphasis given to certain methods of technique, forms of apparatus, etc., rather than to the application of definite and well-established principles of treatment to the various conditions met with in this affection. Special surgical procedures have been given more prominence than the study of the particular indications which each case presents and on which the selection of the method of treatment depends.

The recent interest in this subject is evidenced by the large number of papers which have been presented. These contributions are not necessarily an indication of the difficulties met with in the course of treatment or of concern with the general problem, but, rather, of interest in new or modified methods of technique and mechanical devices, many of which are not remarkable for originality or for any special difference from the original. We may question whether the emphasis on these details is not suggestive that sufficient attention has not been given to the selective adaptation of those measures which we already possess and of technique with which we are already familiar.

To the surgeon who is occupying himself with the operative problem in this treatment, the special technique is not particularly important, for he will be able to apply his surgical skill to any operation. It is, rather, the application of his individual skill and experience to the special procedure which he may choose as best adapted to the case in hand. The important factor is his choice of procedure. It is not so much a question of whether or not union of the fragments can be obtained by one of the recognized methods as it is of whether or not the fragments of the joint are of sufficiently normal structure to allow the joint to function in a satisfactory manner after it has been restored. In the one case, we may choose one of the methods which promises union; in the other, we should make no attempt to restore the architecture of the joint, but should content ourselves with a joint which has limited function. After making this decision, the surgeon can then select the technique which in his judgment is best suited to the task.

In making a decision in regard to the choice of the treatment to be

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

selected, the following features are to be taken into account: the character of the break; the amount of absorption of the neck; the size of the head and the amount of atrophy; the condition of the acetabulum and, in fact, of all the remaining structural elements of the joint which may be used in restoring function by whatever method the operator may decide to employ. Of equal importance with the local factors are the general factors,—namely, the age; the general condition; the amount and kind of activity engaged in by the patient; and the demands which his social status will put on the restored joint.

The various accepted methods of operation, with their modifications, can be easily put into two groups, according to the principles upon which they are based and the goal which they attempt to reach:

1. Those which, in the presence of intact articular structures, aim to preserve the parts and to restore as far as possible the normal architecture of the joint.

2. Those which, in the absence of normal joint structures, are destructive in principle and aim to use non-articular structures to perform a portion of the rôle of the normal joint structures.

The former attempts to restore to the joint a large percentage of normal function; the latter makes no such attempt, but, with the use of other non-articular structures, endeavors to regain as much of the normal function with weight-bearing as existing anatomical conditions can with reason promise. The employment of the first type presupposes the presence of articular structures sufficiently normal to resume joint function when the architecture has been sufficiently restored; the other accepts the damaged parts as a fact and endeavors to use them to the best advantage, recognizing that an imperfect joint must be accepted as a final result. Each case calls for an estimate of its potential capacity for function, based on the condition of the joint structures which remain.

In this estimate, it is necessary to formulate the essentials of a normal joint,—namely, (1) normal area and line of the joint cartilage; (2) freedom from arthritic changes; (3) preservation of a reasonable degree of bone density of the head fragment. It is a fact that some degree of change in the structure of an uninjured joint is compatible with satisfactory use, but it must be recognized that, after so severe an injury, these changes gradually become more pronounced, with a resultant increasing incapacity. Therefore, when these articular changes exist, even if they are not pronounced, the joint is not likely to stand the test of time and of the stress of an active life. These facts must be reckoned with in planning for the late end result, and these local conditions must influence the choice of procedure. Along with this, the social status of the patient makes equally strong demands for recognition and often must be the important deciding factor. The decision, therefore, must be made as to whether we shall attempt to restore, as far as possible, the normal architecture and function of the joint, or whether we shall compromise and be content with a less perfect end result.

In the first type of case, in which the aim is to restore the structures to their former relative positions, it is not advisable to insist upon or even to advocate too exclusively one method of reuniting the fragments. The essential principle is practically the same in all of the different procedures. In some, the surface is cleared of fibrous covering and thoroughly refreshened; in all, the fragments must be replaced and held in firm apposition. In the old cases, in which bone atrophy always exists, this firm contact is particularly imperative. Whether this retention is accomplished by interposition of bone grafts, nails, or wires for fixation of the limb with or without artificial impaction, the maintenance of this contact is imperative in proportion to the diminished size of the head fragment and the amount of existing bone atrophy. In some of these cases the advisability of extraneous material, with the local trauma incident to its insertion, is decidedly debatable. It is the author's belief that sound surgery demands the largest possible contact of cancellous bone on each fragment and the least amount of extraneous material placed in these parts. The transplantation of the head fragment to the freshened upper and inner surface of the trochanter, with so large a surface of bone contact, in a position which does not tend to displace, frequently provides the best physiological conditions for quick return of vitality to the head fragment.

In the other type of case, in which there is not sufficient normal structure remaining to permit joint function, the choice of procedure is somewhat more difficult. With the marked atrophy of the head, the thinning or disappearance of the cartilage line, and the arthritic changes around the joint, either about the femur or the acetabulum, or both as is usually the case, the potential for good function (weight-bearing and motion without pain) is not offered. It is necessary to estimate how much function, based on the consideration of both local and general conditions, as well as on the social status, it is possible to expect, and then to select that operative procedure which seems best fitted to fulfill these indications. We must choose between the use of the remaining articular structures placed in contact with the acetabulum, with the object of obtaining a pseudarthrosis—whether by the method of Whitman, by putting the lesser trochanter into the cavity of the acetabulum, or by some of the more recent modifications of reconstruction operations—or an immediate ankylosis, sacrificing the convenience of motion to the greater strength and to the more practical use of painless weight-bearing.

The various operative procedures with their rather refined techniques and the many mechanical devices which may be employed have been so elaborated and often perfected, and the different conservative measures with their results have been so freely given to the medical public, that we have now quite a sufficient equipment to meet whatever conditions are presented. At present there is need of special study and observation, particularly by the collection of end results, to aid in the application of these methods which we already have to the various types of cases, and to act as a guide in the choice of the method of treatment. The result

after a few months, or even after a few years, may not furnish accurate evidence for the estimation of the value of the procedure. Even the mechanical irritation accompanying the use of an imperfect joint may be sufficient to change the first indication of success into the final fact of failure. These joints, traumatized by the original injury and later by operation, show marked anatomical and pathological defects and they often continue to exhibit progressive changes in their character, so that true end results cannot be estimated until after a much longer period than that of the usual fracture case.

The definite demand at present is not the study of the end results of a special method of treatment or of a particular technique. These various procedures have been given sufficient prominence to enable any surgeon of ability and experience to use any one with precision. What is needed is a more thorough study of the various conditions which these different joints present, with the means of estimating the potential capacity of each to respond to the demands which the activities and the social status of the patient will make on it in the years which follow, in order to determine which operation promises to give the type of joint best suited to the individual's needs. We should have more knowledge of end results obtained by the various procedures which have been selected with reference to the potential function which remains to a joint after it has passed through the trauma of the injury and the superimposed trauma of any operative procedures. Such data would aid us to choose more wisely the course to pursue.

COMMENTS ON INTERNAL FIXATION IN FRESH FRACTURES OF THE NECK OF THE FEMUR *

BY W. W. PLUMMER, M.D., BUFFALO, NEW YORK

The whole problem of the treatment of fresh fractures of the neck of the femur has been so thoroughly discussed in the literature that it is unnecessary to undertake a preliminary presentation of the history of the development of this procedure. It is sufficient to state that, since Smith-Petersen's work in 1931, there has been a rapidly growing conviction on the part of many surgeons that internal fixation of these fractures is the ideal method of treatment for this group of serious and disabling injuries.

In this paper the reader will recognize the influence of the work of many men who have already demonstrated the fundamentals in this particular field. Without later specific references to writers or to details of method, the author wishes to pay tribute to the courage and ingenuity of Smith-Petersen, Johansson, Gaenslen, Moore, Wescott, White, and others who have contributed to the development of this excellent operation. Our own personal experience with internal fixation of hip fractures, while brief in time, includes enough cases to warrant the expression of an opinion as to the general desirability and justification of this method of treatment.

ANALYSIS OF CASES

Since September 1935 and up to May 1, 1937, there have been referred to our Service in the Buffalo General Hospital a total of thirty-seven consecutive cases of fresh fracture of the femoral neck. Of these patients, two died almost as soon as they were admitted to the Hospital. All of the remaining thirty-five patients were operated upon and some form of internal fixation was employed. Thirty-three cases would properly be classed as intracapsular fractures, while two were fractures at the base near the trochanter. The ages of the patients ranged from forty-six to ninety-two, and at one time the average age was seventy-eight. Lately the average has fallen to about seventy-five. Nine of the thirty-five patients in this series have died,—two within the ten-day postoperative period. The other seven survived for periods varying from one month to eighteen months, and died of cancer, incorrigible diabetes, and other causes due to their senescent state.

RESULTS

The immediate postoperative results in this series of cases would alone, in the author's opinion, be sufficient justification for the internal-fixation operation. The patient is comfortably and easily cared for in

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

bed, he has no pain, and he is completely relieved of the apprehensions of a long and exhausting bedridden period in plaster or traction.

It would, of course, be ridiculous to discuss end results in this series, but a rough analysis of functional results is interesting. Twenty-six of the patients are living. Four have been operated upon too recently to be counted at this time; the remaining twenty-two are comfortably ambulatory, their functional ability apparently depending on their age and general condition rather than on what might be termed their actual hip function, which seems to be good.

With the exception of one hip with a fracture near the trochanter, none of these hips up to this time have shown any tendency to relapse into the external rotation—varus deformity—present in all cases of fracture of the hip. In this one case, in the fourth week, the roentgenogram showed a collapse of the posterior fracture area with an external rotation—varus relapse. However, the patient now has a painless stable hip with better function than the roentgenogram would lead one to expect. The follow-up roentgenographic examinations in all these cases demonstrated a varying degree of neck shortening, but no evidence of change from the stable weight-bearing relationship of the fragments attained at the time of reduction. The writer has been surprised at the absence, up to the present time at least, of any signs of arthritic changes in these hips. All of the patients have shown a remarkable recovery of balance and muscle tone; in fact, none of them has suffered any of the usual muscle atrophy and loss of knee function associated with the use of plaster or traction fixation.

CRITERIA FOR END RESULTS

In evaluating end results, the writer believes that too much emphasis has been placed on the feature of apparent bony union. It is a well-known fact that, no matter what the method of treatment, a certain number of cases of hip fracture in all the age brackets have eventually progressed to a demonstrable solid bony trabeculation across the fracture area. However, it seems to the author that one could reasonably express a doubt as to the roentgenographic interpretations usually presented as a basis for the reports of a high percentage of cases of bony union resulting from this or that procedure. In the majority of the younger patients, with good reduction and internal fixation, bony union can be expected. This is confirmed roentgenographically after a sufficient length of time, by the areas of repair invasion of the head by new bone trabeculae from the neck in the manner suggested by Phemister. This favorable result will be obtained only if the fixation method has been effective in retaining the proper weight-bearing relationship of the fragments.

In the older patients, we probably must be satisfied with a satisfactory weight-bearing function, and perhaps assume that the fixation nail will be the chief factor in maintaining a useful leg for these patients during the rest of their lives. In other words, the writer would like to propose

that we classify our end results in terms of walking function without relapse into varus—external-rotation deformity—rather than by roentgenographic interpretations of the extent of the bony trabeculation bridging the fracture line. What will ultimately become of the nonvitalized head, if such it is in cases without bony union, still remains to be determined after a longer and more extensive experience.

TYPE OF OPERATION

From the start of our series we have elected to reduce these fractures and to fix the fragments without opening the hip joint. All of the patients have been operated upon by way of the lateral thigh incision, exposing the trochanter and adjacent shaft. This plan was followed for the same reasons as have been given by other men advocating this type of operation.

The operation involves additional apparatus and equipment in that it requires efficient x-ray facilities in the operating room and some special instruments of precision. However, it makes possible the benefits of internal fixation for many frail and aged patients who could not possibly be expected to survive both a hip fracture and an arthrotomy. Also the author believes that in an arthrotomy the section of many of the supporting tissues of the hip joint, including the capsule, has often led the surgeon to the faulty assumption that open reduction is necessary.

METHOD OF REDUCTION

In general, we have followed the Whitman-Leadbetter procedure of reduction, in which the injured leg is fixed in full internal rotation, with such flexion and abduction as seems wise. Apparently in practically all of our cases the posterior capsule was sufficiently intact to act as a splint for the reduced fracture and to hold the fragments in firm contact when the leg was fully rotated inward. In two cases, internal rotation rolled the neck fragment onto the front of the head, and lateral traction was necessary to adjust the fragments. When anteroposterior and lateral roentgenograms showed the reduction to be satisfactory, the position of the leg was not shifted until the operation was completed. This was accomplished by a special table which, by means of mechanical devices, was readily adjustable to any desired leg position and maintained a continuously fixed relationship between the femur and the x-ray projection apparatus. This complete and continuous mechanical holding of the injured leg, plus an x-ray technique which produces uniform roentgenograms of the hip joint from accurately standardized distances and angles, constitutes the most important part of the operation. In fact, the writer feels that the recent remarkable advances in roentgenography have made it possible to transform the so-called "blind hip-nailing operation" into a precision procedure.

FIXATION INSTRUMENTS

In our series we have used Kirschner wires, Austin Moore pins, and

the Smith-Petersen trefoil nail. In the first four cases the fragments were speared with the wires. This is not a satisfactory method. The wires are inadequate mechanically, dangerously prone to wander into the pelvis, and, in the writer's opinion, should be abandoned. In the next eighteen cases the Moore multiple pins were used. This method has in our hands produced consistently good results. However, here again the method fails to satisfy completely the mechanical requirements. Only one of the three pins can be located in the cortex, neck, and head, so as to resist effectively the sheering strain of muscle pull and weight-bearing. While the combined surface areas of the three pins is approximately only 20

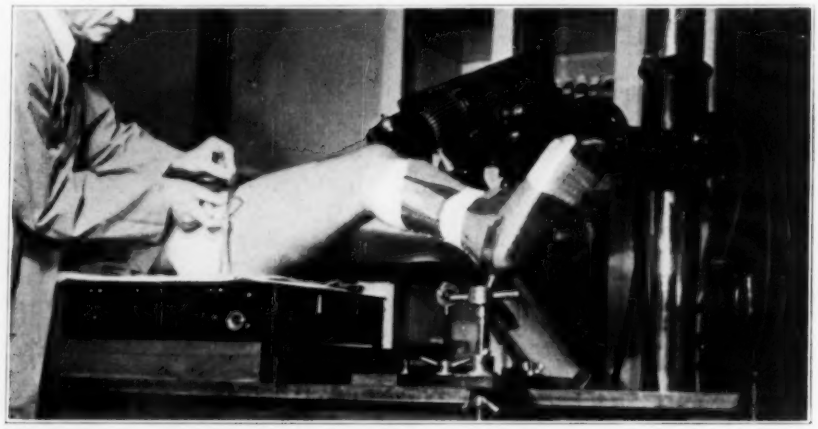

FIG. 1

Table device which makes possible the determination of the exact point of entrance of the nail, of its length, and of the angle of incidence to the shaft.

FIG. 2

Method of obtaining the lateral roentgenogram.

per cent. less than that of the usual trefoil nail, the area is so divided as to be much less efficient in all three of the mechanical factors,—namely, resistance to sheering strain, rotary movement of one fragment on the other, and, of less importance, any possible "draft" effect which the fastening might have. In all of the remaining cases of this series the trefoil nail has been employed.

It seems to the author that the Smith-Petersen nail as modified by Warren White meets in every way the requirements for this type of fixation instrument. Beautifully machined from completely corrosion-resistant chrome-nickel steel, its thin, sharp blades disturb a minimum amount of bone, while its flat surfaces and slightly more bulky head tend to anchor the nail fimly in the compact cancellous bone of the femoral head, as well as in the denser cortex of the shaft. The writer can see no advantage in the use of threaded screws or bolts, and certainly no metal that undergoes chemical corrosion or electrolysis should be inserted into these bones. Chrome-nickel steel of accepted formula is both corrosion-resistant and non-magnetic. Two of these nails were immersed in a solution corresponding to the physiological body fluids at body temperature, one under aerobic and the other under anaerobic conditions, for three months. After removal, neither nail showed even a suggestion of tarnish or of oxidation.

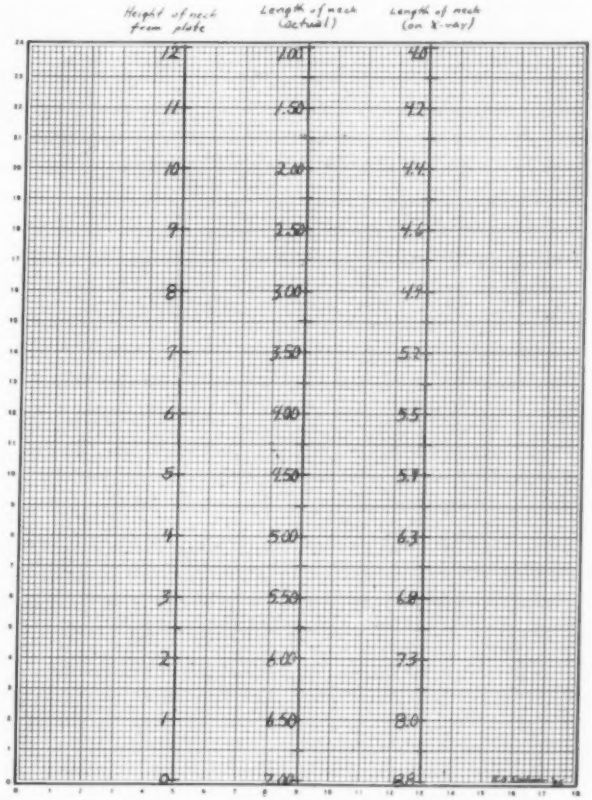

FIG. 3

Graph for calculating the actual neck length.

OPERATIVE TECHNIQUE

Following closely the procedures of Smith-Petersen, Johansson, and Wescott, we have, at the time of publication of this article, operated on forty-three fresh fractures of the neck of the femur in forty-two patients. In no instance has the hip joint been opened, internal fixation after reduction having been attained via the usual lateral thigh incision. The determination of

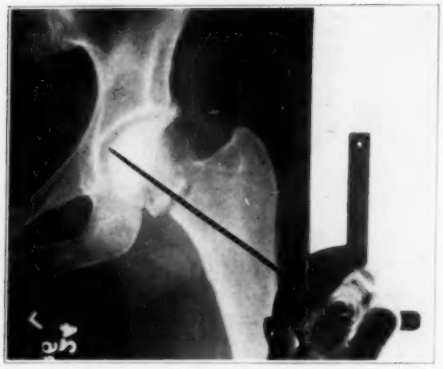

FIG. 4

Modification of Wescott's protractor by which, on the postreduction film, the angle for the proper nail location is read and the total length of cortex, neck, and head is determined.

FIG. 5

Divider used to measure on the postreduction film the distance down the shaft from the ridge.

the exact point of entrance of the nail, of its length, and of the angle of incidence to the shaft is made possible by the table device shown in Figure 1. With the patient already in position on the flat Bucky diaphragm, the fracture is reduced and the leg holder is adjusted to the leg in any position which seems proper. The usual leg position is the one shown in the illustration,—namely, moderate flexion and abduction and *full* internal rotation. In this way the injured leg remains constantly and rigidly fixed in relation to the top and edge of the Bucky diaphragm, so that anteroposterior and lateral roentgenograms of the neck of the femur will be exactly duplicated throughout the entire operation. In making the anteroposterior roentgenograms, the x-ray tube is always centered over the hip at exactly the same distance from the top of the Bucky diaphragm.

The lateral roentgenogram, shown in Figure 2, is made by aiming the tube at the femoral neck along an imaginary line called the pelvic line, from the lower edge of the symphysis pubis to the superior iliac spine, with the central beam of the tube inclined exactly 35 degrees below the horizontal. The cassette in its sterile cover rests on the top of the Bucky diaphragm with the edge pressed into the patient's flank and its surface at right angles to the pelvic line and inclined out against a light metal support, exactly 35 degrees from the vertical. At this time also a measurement is taken from the top of the table to the center of the mass of the femoral shaft as outlined by the thumb and forefinger (Fig. 1). By means of this measurement, the exact distance of the hip from the x-ray film can be computed for any given patient. It is called "hip height," it varies widely in different patients, and it is important if we are to compute accurately from the roentgenographic findings the actual distance from cortex to head in any given patient.

Assuming that the position is satisfactory, the postreduction films are now ready for use. By using a modification of Wescott's protractor with its base on the edge of the film (Fig. 4), certain data are obtainable. The angle for the proper nail location is read. The total length of cortex, neck, and head along this line is determined and noted. The distance down the shaft from the ridge is measured with a divider (Fig. 5). While these angles and distances are being noted, similar sterile instruments are being set and adjusted by the operating-room nurse.

FIG. 6

Small drill and dividers used to spot the entrance of the nail.

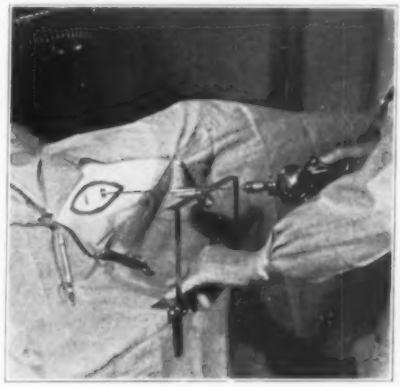

FIG. 7

A long, fairly stiff guide wire is drilled into the shaft, neck, and head. Note the adjustable stop located on the wire at the predetermined nail length from its entering tip.

To save time in calculating the actual neck length in the patient, which is a matter of arithmetical proportion, we have a prepared graph (Fig. 3) based on a constant height from tube center to film used in all cases. The left-hand column represents the height of the hip from the film. The right-hand column shows the length of the neck as measured on the roentgenogram. For example, if a straight edge is placed on *8* inches in the left-hand column and on the roentgenographic measurement, *6.3* inches in the right-hand column, it will cross the center line just above *4*, which will be the exact length in inches from shaft to head, and a nail, three and three-quarters inches in length, is indicated.

With the lateral aspect of the shaft

FIG. 8

Nail lying full length in the denser portions of the bone.

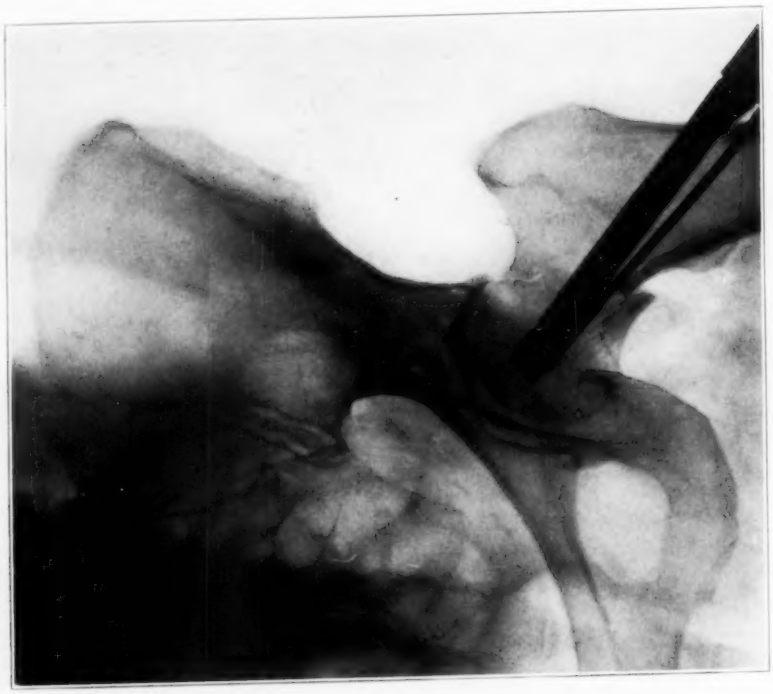

FIG. 10
Nail driven into neck.

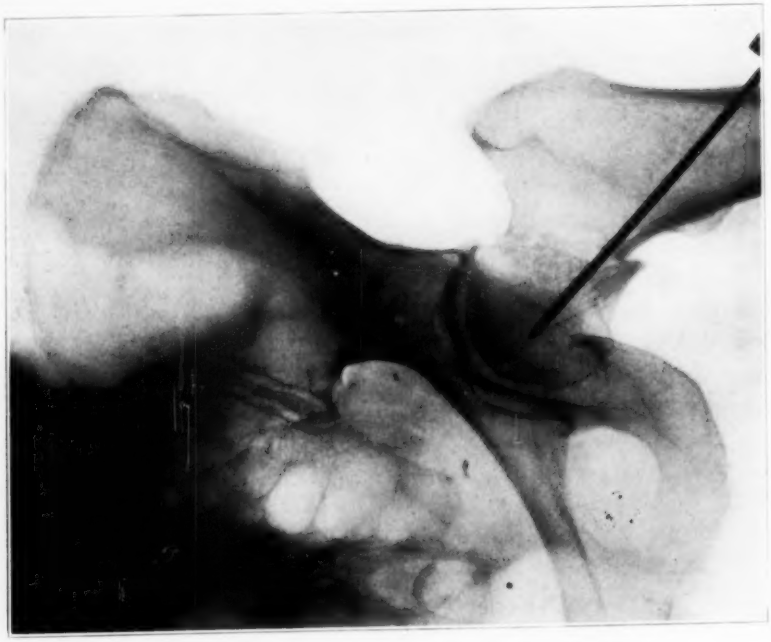

FIG. 9
Guide wire in place.

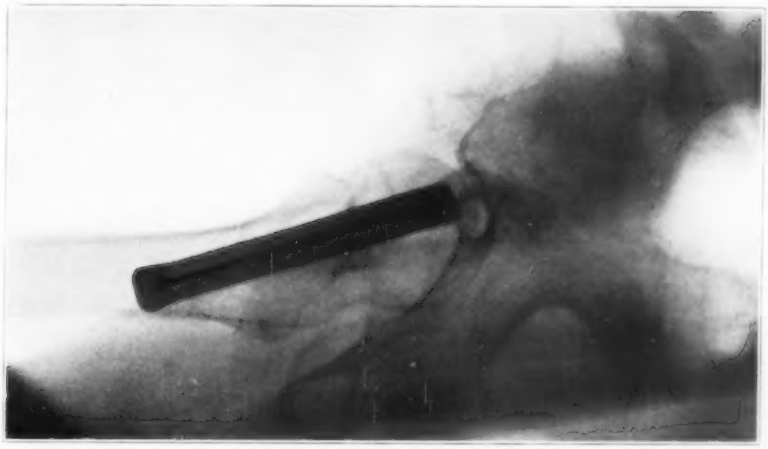

FIG. 11

Lateral roentgenogram to check the position of the nail.

exposed, the point of entrance of the nail is spotted with a small drill and the dividers as shown in Figure 6. With a protractor constructed to transfer the angle read from the roentgenogram to the operating table in a generally horizontal plane, a long, fairly stiff guide wire is drilled into the shaft, neck, and head. An adjustable stop is located on the wire at the predetermined nail length from its entering tip. (See Figure 7.) We try to keep the guide wire in contact with the inferior surface of the medullary canal of the neck in order to later place the nail so that its full length lies in the denser portions of the bone as shown in the specimen illustrated in Figure 8. If the Warren White instruments are used, the nail is easily and accurately driven

FIG. 12

Ninety-degree projection taken after the wound had been closed and dressed.

FIG. 13-A

FIG. 13-B

Roentgenograms of right and left hips taken in August 1937, showing in each case some shortening of the neck, but the weight-bearing relation of the head is good.

parallel to the guide wire and at such inclination to the horizontal surface of the table as has been determined by the first lateral roentgenogram taken.

Figures 9 and 10 show the guide wire in place and the nail driven. Figure 11 is a lateral roentgenogram to check the position of the nail. Finally, after the wound has been closed and dressed, the thigh is flexed at a right angle and the 90-degree projection shown in Figure 12 is made if desired.

While the procedure described may sound complicated, it is really very simple. No novelty is claimed for any part of it, with the possible exception of the table and x-ray combination, and here our only point is that, with fixed and rigid relations of leg to roentgenographic-projection distances and angles, it becomes possible to insert and to drive the right sized nail at the proper location with complete confidence and assurance that the nail will not go astray. The whole procedure takes from fifty to seventy minutes from the time the patient is placed on the table. This includes reduction, the taking of the three sets of two films each to check reduction, the insertion of the guide wire and nail, and of course the actual operating time which is really quite brief.

The roentgenograms shown in Figures 13-A and 13-B are interesting and were made late in August 1937. The patient, aged seventy-eight, was operated upon early in March 1937, and a fracture of the left hip was re-

duced and the fragments were nailed. In July she was walking comfortably with a good functional left hip, when she fell over a rug fracturing the right femoral neck. An operation was performed on this hip and the fragments were nailed. Both femoral necks show some shortening, but the weight-bearing relation of the head remains good. The patient is apparently once more on her way to obtaining useful and comfortable function of both hips.

CONCLUSIONS

1. Internal fixation of fresh fractures of the femoral neck has been demonstrated by the work of many surgeons to be a justifiable and reliable method of treatment for this important and serious injury.

2. Internal fixation of these fractures can be accurately and successfully accomplished without the added hazards of a hip-joint arthrotomy.

3. This procedure should not be classified as a simple and casual operation to be done under any and all conditions. However, judged on the merits of reported results from many clinics, this plan of treating hip fractures is worth all it costs in the way of expensive and special equipment and deserves the thoughtful consideration of all surgeons charged with the care of these cases.

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CLOSED REDUCTION OF FRACTURES OF THE NECK OF THE FEMUR*

BY GUY W. LEADBETTER, M.D., WASHINGTON, D. C.

In the treatment of intracapsular fractures of the neck of the femur, the efficacy of any single procedure depends on the skill of the individual surgeon, his judgment, his experience with the type of fracture at hand, and the general condition of the patient with particular reference to his recuperative powers and to no small extent to his mental cooperation. The cardiovascular-renal system should be examined carefully for any organic disease or decompensation. Dehydration, when present in the elderly patient, should always be recognized and treated before any attempt to correct the injury is made. Intestinal stasis is an important element to be considered, especially in the patient of advanced years.

At the present time two general types of procedure are widely used by qualified fracture surgeons. One school of thought advocates closed reduction and plaster fixation; the other chooses closed reduction with some form of internal fixation, the Smith-Petersen nail being used by the majority, although the three-pin internal fixation has been reported to have yielded excellent results. The technique, however, of both of these operations is essentially the same.

The end results of the treatment in the past are shown in Table I.

The author wishes to report a series of eighty-one cases treated for fracture of the neck of the femur. Fifty-nine of these were followed accurately. The ages of these fifty-nine patients ranged from forty to ninety-two years, and the period of observation extended from one to nine years. All of the patients were treated by closed reduction and skin-coaptation plaster fixation. Good union resulted in 71.18 per cent.; good function but no bony union in 6.79 per cent.; failure in 13.57 per cent.; and death in 8.46 per cent. Thus 22.03 per cent. of the cases resulted in failure. The average time in plaster was ten weeks. The average time of recumbency was twelve weeks. Full weight-bearing was not allowed for six months.

These results are apparently commensurate with those reported in other recent series and seem to represent about all that may be expected from this particular procedure, although ambulatory treatment such as that suggested by Kleinberg may offer a higher percentage of good end results. There is considerable ingenuity in this procedure and we should not be too hasty in condemning such technique.

Meticulous attention to the proper and anatomically accurate reduction of the fragments is certainly the first step in any procedure. To be satisfied with even an approximate reduction is not sufficient, statements

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

TABLE I

END RESULTS OF CLOSED REDUCTION OF FRACTURES OF THE NECK OF THE FEMUR

Date Reported	Author	Method	No. of Cases	Bony Union (*Percentage of Cases*)
1913	British Fracture Commission	Conservative		13.8†
1913	British Fracture Commission	Conservative		22.0
1914	Walker	Conservative	112	13.0
1923	Campbell	Abduction	21	75.0
1923	Campbell	Tibial graft	12	58.3
1928	Katzenstein	Conservative	119	11.5
1929	Albee	Tibial graft	39	97.4
1930	Fracture Commission of the American Orthopaedic Association	Abduction	210	53.8
1930	Reggio (Records from the Massachusetts General Hospital)	Abduction	49	49.1
1931	Smith-Petersen	Nail	20	75.0
1931	Stern	Abduction	15	87.0
1932	Campbell	Abduction	75	53.3
1934	Henderson	Abduction	36	66.6*
1934	Henderson	Bone graft	53	69.8*
1935	Moore	Three pins	20	85.0**
1935	Dickson	Abduction	68	70.0
1935	Dickson (from two clinics)	Nail	31	83.3
1935	Dickson (from his own clinic)	Nail	9	77.0
1936	Krida	Tibial graft	6	66.6***
1936	Henderson	Nail	7	100.0
1937	Moore	Three nails	24	96.0

† Patients over sixty years of age.
* Not counting two deaths.
** Counting three patients who died.
*** Counting two patients who died.

to the contrary notwithstanding, no matter what the method of fixation may be. It has been conclusively shown that these fractures can be reduced by careful manipulation.

For the sake of clarity, it seems wise to reiterate the steps in reduction and fixation described in the paper read by the author at the meeting of the American Orthopaedic Association in Toronto in 1932. The injured leg is flexed at the hip at 90 degrees. Manual traction is applied in the axis of the flexed thigh, together with slight adduction of the femoral shaft. In this position the thigh is internally rotated, and the leg is slowly circumducted into abduction, the internally rotated position being maintained. As the leg is brought down to the table level, the heel-palm test should be applied to confirm position. The amount of measured abduction is determined by inspection of the roentgenograms taken previous to the manipulation, and the angle of the uninjured side is compared with that of the fractured side. The difference in degrees between the two angles is roughly the amount of abduction required. It can be still more accurately determined and verified by applying the heel-palm test which allows only a few degrees' variation in abduction or adduction before change in the position of the leg takes place,—for example, if the leg is carried too far toward the adduction side, it will slowly evert itself in the palm of the hand and give evidence of disengagement of the fragments. If abduction is forced beyond the normal limits necessary to maintain coaptation of the fragments, then greatly increased tension of the adductor muscles will be felt and there will be a tendency for the knee to flex slightly. This has been found to be a very satisfactory method of determining the amount of abduction in the reduced fracture. The leg is then held by an assistant without traction, and the plaster is applied as follows. A one-layer thickness of glazed cotton is placed about the torso from the nipple line over the affected hip to a point about half-way between the hip and the knee. Then a long strip of felt, one-half an inch thick, is placed about the pelvis, extending from just above the iliac crests to the trochanters, and completely encircling the pelvis. This is all the padding necessary and allows very tight application of the plaster. The body portion is first applied as tightly as possible, snug coaptation being the aim. Firm pressure over the injured hip is necessary. Below the hip no padding is applied. Two plaster slabs, molded carefully to the contour of the leg, are bandaged closely to the skin, one posteriorly and one anteriorly. Padding is placed beneath the heel, and the plaster is molded well and coapted snugly. Circular plaster is applied around the two molded leg splints. Care is taken to carry the cast high under the pubis and the ischium with sufficient felt padding which is cut very closely in the trimming of the cast. The U is then cut from the body segment of the cast anteriorly, leaving the sides high in order to prevent the patient from swinging to the opposite side, thereby changing the relative position of body and leg. Extreme abduction is rarely necessary. It is quite clear that the valgus position is best. Only in rare cases does full

abduction allow such valgus position. It has been the author's experience that by far the majority of cases demand very little abduction.

Several men have indicated that they change the plaster after three weeks. This is to be commended, especially in handling stout individuals. We all experience the problem of the loose cast in such patients Fixation is less secure, although the skin-coapted plaster diminishes the chance of slipping. The necessity for change may be determined by frequent inspection of the cast. Roentgenograms taken immediately after application of the cast and at intervals of two weeks show change of position of the fragments If malposition is noted without absorption of the neck, reduction should again be done and the case treated as before.

During the active convalescent period it has been our custom to put the patient in the erect position as soon as possible, permitting him to walk without a caliper brace but with crutches. While no weight-bearing is allowed, he is painstakingly taught to walk with regular rhythm of gait, touching the foot of the injured leg to the floor but not applying any force. In this way an early regulation of gait is established. There is a fairly rapid improvement in the tone of the muscles of the hip and the leg, and it is not so difficult, when the time comes, to wean the individual from crutches. Two canes are first substituted and these are rapidly followed by one. The discarding of the last cane is left largely to the patient's discretion.

As shown by the reported results in the last eight years, the efficiency of treating these fractures has increased. We should bear in mind that probably no single method is adaptable to all cases and to all localities. A recent questionnaire which the author sent to orthopaedic surgeons, to general surgeons, and to general practitioners in all sections of the country revealed some interesting figures. They grouped themselves very sharply into two units. The agreement of estimated figures in these units was striking.

In the cities of 20,000 population and over, it was found that an average of 71.18 per cent. of the cases were treated by the orthopaedic surgeons, 23.5 per cent. by the general surgeons, and 5.5 per cent. by the general practitioners. The procedure employed was chiefly plaster application with the abduction treatment and internal fixation. Practically no cases of actual open reduction were reported.

In cities and towns of 20,000 population and under in the rural districts, an average of 39.9 per cent. of the fractures of the neck of the femur were treated by the orthopaedic surgeons, 46.1 per cent. by the general surgeons, and 14.1 per cent. by the general practitioners. Here the treatment varied widely from sand-bags to suspension traction, the Roger Anderson splint, plaster, and only occasionally internal fixation.

These figures present an argument in favor of teaching two methods,—namely, closed reduction with plaster cast and closed reduction with internal fixation.

We cannot know what dire results may present themselves if those

unskilled in the technique of internal fixation attempt such treatment, and, until we are able to educate the profession and the laity in general to the fact that internal fixation is a technical procedure, it is the author's feeling that we should continue to teach the old method as well as the new.

These two procedures are truly a fine armamentarium and, as in other fractures, the writer feels that we should apply the rule of conservatism whenever reasonably possible and utilize internal fixation when in our judgment it is necessary. In the last year and one-half we have applied this rule with what appears at the present time to be very satisfactory results, although the cases have not been followed long enough to state so definitely. We have nailed approximately 75 per cent. of the fresh fractures and in the remainder have applied the plaster-fixation method.

In selecting the cases, the patient's age, his general physical condition, his muscular condition, and, to no small extent, his choice (some patients object to nailing) must be considered.

It is not by one single stereotyped form of treatment that the problem of the fractured hip will be solved. Both plaster fixation and internal fixation should be taught. Open reduction is not necessary, but, in the final analysis, it cannot be denied that internal fixation is more adequate than plaster, and that early mobilization of the individual is most important in preventing chronic disability in the aged. Plaster fixation cannot be expected to yield good results consistently and logically in more than 65 or 75 per cent. of the cases.

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EXPERIENCES WITH INTERNAL FIXATION IN FRESH FRACTURES OF THE NECK OF THE FEMUR *

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During the past three years, on the Fracture Service of the Toronto General Hospital, we have been treating fractures of the neck of the femur by internal fixation, and, in general, our experience has been such as to make us enthusiastic advocates of this method. Two years ago Dr. Kellogg Speed referred to this fracture as "The Unsolved Fracture". Today that opprobrium is almost completely removed, due to the great advance in the treatment of this difficult surgical problem by means of internal fixation. The method is based on sound principles and, although there may be a number of technical problems yet to be solved, the importance of the contribution is established, and, in our judgment, it will govern the future treatment of these fractures.

This paper is based upon our experience. It is concerned chiefly with certain difficulties which we have encountered, and it is presented with the hope that frank discussion of such difficulties may lead to further simplification of methods and improvement in results.

The principle on which the success of the method is based is a simple one, although before the introduction of the Smith-Petersen nail it was not clearly recognized. It is this: in a fracture of the neck of the femur, as in any other fracture, the fragments will unite if (1) the fracture is accurately reduced, (2) the fragments are placed in close contact with one another, and (3) the fragments are *maintained* in contact with each other *without any movement whatsoever* during the whole period of healing. The last requirement is of incomparably greater importance than the other two. If these requirements are attained, union will take place irrespective of the problem of the blood supply of the head of the femur. Even though the femoral head is deprived completely of its blood supply and undergoes complete aseptic necrosis, union will still take place if contact without movement is rigidly maintained. A graphic illustration of these principles is the observation that truly impacted fractures of the neck of the femur will always unite provided the impaction is allowed to remain undisturbed. So important is this observation that it has come to be our practice to leave impacted fractures undisturbed, as we feel that the certainty of union in 100 per cent. of cases greatly offsets the disadvantages of any minor degree of deformity (usually external rotation). Truly impacted fractures are rare (comprising not more than 10 per cent. of all cases of intracapsular

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 2, 1937.

fractures of the neck of the femur), but they can be recognized by certain signs: (1) a relatively slight deformity, especially a small amount of shortening; (2) the relatively slight amount of pain; (3) the ability of the patient to move the leg voluntarily, at least to some degree; (4) occasionally the ability of the patient to walk on the leg.

Whitman's abduction method of treatment marked a great advance solidly based on sound principles, but it has its shortcomings, as is evidenced by the percentage of failures to secure bony union. This is due to the inability always to secure perfect fixation of the fragments, even by the use of abduction and a plaster spica. A very brief experience with the plaster spica will convince one of the impossibility of keeping the hip joint completely at rest. So much soft tissue is interposed between the plaster and the joint that the patient can move within the plaster, and complete immobility of the fracture line is rarely attained. Further, if the knee joint is freed for exercise during the period of plaster fixation, the pull on the quadriceps, from its origin on the ilium to its insertion in the patella, exerts a force which pushes the shaft of the femur upward and sheers across the line of fracture, completely disturbing the absolute fixation of the fracture which is essential for union. It is this fact which makes reduction with the head in valgus and the Schanz osteotomy valuable adjuncts of treatment. They alter the relationship between the line of fracture and the forces playing upon it, so that the latter are expended in forcing the fractured surfaces together instead of sheering one across the other. The great contribution which has been made by internal fixation of fractures is that it secures adequate fixation of the fracture line and simulates the situation which exists in impacted fractures.

In the past three years the Fracture Service of the Toronto General Hospital has treated fifty cases of intracapsular fracture of the neck of the femur by internal fixation. The Smith-Petersen nail is the only form of internal fixation which we have used. It has been introduced by various methods, chief among which are: open reduction, as practised by Watson Jones; insertion along a previously placed Kirschner wire, as advocated by Johansson; and the use of a long handle screwed into the nail, as recommended by White. Broadly speaking, our results have been eminently satisfactory. We have encountered some difficulties and some failures. The latter have been due to technical problems which will be discussed later. Our experience leads us to the conclusion that, after satisfactory reduction of a fracture, a Smith-Petersen nail properly placed in the fragments can be counted upon to secure bony union in every case. In addition, the method permits the satisfactory treatment of certain other difficult problems, such as ununited fractures of the neck of the femur, in a manner not hitherto possible.

So impressed are we with the value of the method that we believe we may accept its success as proved. More is to be gained by discussing difficulties and imperfections which lead to poor results.

THE IMPORTANCE OF GOOD ROENTGENOGRAMS

Our experience would indicate that certain factors are of vital importance in the success of the procedure. It cannot be too strongly emphasized that the insertion of the nail is a highly technical procedure, only to be undertaken in adequately equipped hospitals and with a perfect coordination between the X-Ray Department and the operating-room staff. This indeed is one of the greatest shortcomings of the method. It can be undertaken only in the larger hospitals, and hence a large number of patients in rural communities are deprived of the benefits of the procedure. Good roentgenograms are essential to success. In the past we have had difficulty in obtaining uniformly good x-rays, especially in the supero-inferior direction. Some of our failures, or imperfect results, have been

FIG. 1-A

FIG. 1-B

Imperfect result due to protrusion of the nail through the anterior surface of the head into the acetabulum, the result of poor roentgenograms.

Fig. 1-A: Anteroposterior view at time of operation. Lateral view taken at this time was poor, but seemed to show satisfactory position of the nail.

Fig. 1-B: Lateral view eight months after operation, revealing the cause of the patient's pain on weight-bearing and walking. The fragments united in fair position; there was moderate limitation of movement, due to arthritis. The nail was removed.

due to this cause. It is quite possible to accept as good enough the position of the nail on the evidence of a poor supero-inferior roentgenogram, only to find after a lapse of months that the nail has an imperfect grasp on the head or has deviated from the central line of the neck, or has penetrated the head posteriorly or anteriorly and is impinging on the acetabulum. This fault can be eliminated by good supero-inferior x-rays. Such should be insisted upon, no matter how much it delays the operation. (See Figures 1-A and 1-B.) The essential features with which the X-Ray

FIG. 2-A

FIG. 2-B

FIG. 2-C

Imperfect result from too early weight-bearing (three weeks after operation).

Fig. 2-A: Good reduction and good position of nail at time of operation.

Fig. 2-B: Three months after operation. The head has shifted downward from too early weight-bearing; the neck is absorbed; the angle of the nail is changed; and the nail has been pushed out backward through the trochanter.

Fig. 2-C: Further settling downward of the head on the neck and further protrusion backward of the nail. Union took place in this position.

Department must be able to provide the surgeon to ensure success are: (1) a portable x-ray machine of adequate power; (2) a technique which will give good views of the fracture in two planes—supero-inferior being particularly important—and permit successive sets of roentgenograms to be compared with each other (this means taking each film from a predetermined position of tube and cassette); (3) developing facilities within easy reach of the operating room, so that the developed films may be seen quickly.

THE DANGER OF BEARING WEIGHT TOO EARLY

The second source of failure is too early weight-bearing. There have been one complete and one partial failure in our series from this cause. It is remarkable how securely the nail will fasten the fragments together. Nevertheless, to bear weight upon the limb before solid union has occurred places a great strain upon the fracture line, and this can cause the head of the femur to be torn off the end of the nail or to shift its position. A striking example of the security of fixation obtained by the nail occurred in a mentally deranged woman in whom a fractured neck of the femur had been treated by insertion of a Smith-Petersen nail. She got out of bed on the second day after operation and from that time on was out of bed walking during some part of every day. Three months after operation she secured a position as housekeeper and has been able to walk ever since. No shift occurred in the fragments and solid union was secured.

FIG. 3-A

FIG. 3-B

Complete failure from too early weight-bearing (one week after operation).
Fig. 3-A: Immediately after operation.
Fig. 3-B: One month after operation. Complete separation of head from neck and from nail.

However, experience with two cases (Figs. 2-A, 2-B, 2-C, 3-A, and 3-B) convinces us that too early weight-bearing can ruin an otherwise perfect operation. We have, therefore, adopted the routine of keeping the patient in bed for eight weeks following operation. It may be that in certain cases even this period of time is too short for solid union to occur and that we should wait for roentgenographic evidences of bony union even though to do so would preclude weight-bearing for six months. Among surgeons of our acquaintance there is the greatest diversity of practice in regard to the time in which weight-bearing is permitted. This phase of treatment we feel is not yet quite solved. Longer experience will be necessary before definite rules can be laid down. Our first impression was that an important advantage in the use of the Smith-Petersen nail was the possibility that the patient might walk within a month of the time of fracture. It is true that early weight-bearing can sometimes be permitted without bad results. This is to be attributed to the rigidity with which the nail fixes the fragments, and does not alter the indisputable fact that great strain is placed upon the point of mechanical fixation. Any imperfection in this fixation will permit movement and mar the results. The difference between a perfect result and an imperfect one or a failure is so great that eight weeks spent in bed is a small price to pay for it. If at the end of an arbitrary period of time, such as eight weeks, any doubt of union exists, weight-bearing should not be permitted until roentgenographic evidence of union is present.

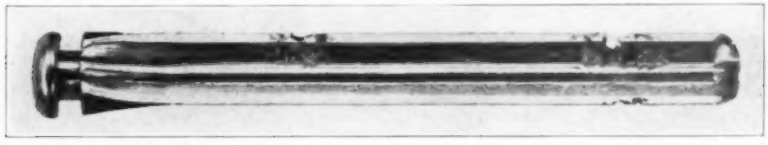

FIG. 4

Smith-Petersen nail of high-chromium, high-nickel, stainless steel but not polished. Marked corrosion necessitated removal of nail, although not until union had occurred.

THE IMPORTANCE OF USING NAILS MADE FROM PROPER STEEL

A third source of difficulty has been but little stressed. This is the quality of the steel which is used for the nails. It is essential that the nail be as completely non-irritating as possible. In order to perform its function, it must stay in place at least for several months. Should any infection or irritation occur during that time, the close association with the hip can lead to disastrous destruction of the joint. (See Figure 4.)

Stainless steel is a generic term used to designate any alloy of steel which resists corrosion, but especially those containing nickel and chromium. There is a very wide variety of these alloys,—they vary in their content of nickel and chromium, in their ability to resist oxidation, in their hardness or softness, and in their ability to be tempered. It should be emphatically stated that not all stainless steels are suitable for use in

FIG. 5-A

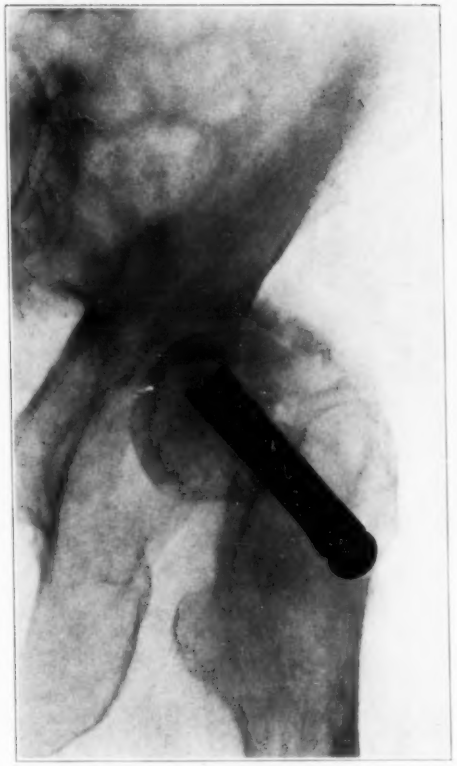

FIG. 5-B

FIG. 5-C

Infection of hip joint, the result of reaction to nail.

Fig. 5-A: Ununited fracture of six months' duration; fragments well secured by Smith-Petersen nail.

Fig. 5-B: Eight months after operation. Reaction about nail resulted in sterile abscess which burst spontaneously through wound. Nail left in place because of necessity for prolonged fixation. Secondary infection of sinus occurred with invasion of hip joint, destruction of cartilage, and upward wandering of acetabulum.

Fig. 5-C: Ten months after operation; nail removed. Union has occurred, but hip joint is grossly damaged.

bone work. The mere fact that a certain alloy of steel will resist corrosion or exposure to air is no proof that corrosion will not take place when the nail is inserted in bone. The so-called high-nickel, high-chromium alloy has proved least irritating and least corrodible.

A further point of great importance is the manner in which the nail is finished, irrespective of the material from which it is made. It has been proved from the researches of Hatfield that the ability of stainless steel to resist corrosion is due to the presence of a film of chromium oxide on the surface of the steel. The smoother the surface of the steel, the more perfect will be this film and the greater the powers of resistance to corrosion. Any imperfection or irregularity on the surface may break the film and permit corrosion to start. Hence, not only should Smith-Petersen nails be made of high-nickel, high-chromium steel, but they should be finished with a high polish. This is a point of some importance, since even a small area of corrosion may set up sufficient irritation to necessitate removal of the nail.

FIG. 6

Imperfect result from an overlength nail inserted through head into acetabulum. Painful movement necessitated removal one year after operation. Good union and good position.

THE DANGER OF USING NAILS THAT ARE TOO LONG OR OF DRIVING THEM IN TOO FAR

We have encountered difficulty occasionally by inserting a nail completely through the head of the femur, either because an overlength nail was used or because it was driven in too far. This problem is comparatively simple to solve, but it does stress the importance of choosing a nail of the correct length. In both cases in which this complication occurred the nail was subsequently removed, because of pain on movement. (See Figures 5-A, 5-B, and 5-C.)

THE VALUE OF SIMPLIFIED METHODS

The greatest shortcoming of the method, however, is the highly technical nature of the procedure necessary to introduce the nail. Smith-Petersen's original technique was of such magnitude that most surgeons

TABLE I

RESULTS OF INTERNAL FIXATION BY SMITH-PETERSEN NAIL IN FIFTY CASES OF FRACTURE OF THE NECK OF THE FEMUR TREATED AT THE TORONTO HOSPITAL

Result	No. of Cases	Per Cent.
Good: Solid union and good function	36	72.00*
Imperfect: Solid union, but poor function Nail too long in both cases	2	4.00
Failure: Sepsis—1 case Too early weight-bearing—4 cases Pin inaccurately placed—2 cases	7	14.00
Death: Sepsis in wound—1 case Pulmonary embolus—3 cases Cardiac failure—1 case	5	10.00

* Good results were obtained in 80 per cent. of the surviving patients.

hesitated to use it on elderly patients who were poor risks. The great stimulus to the use of internal fixation came with the introduction of simpler and less traumatizing methods, especially that of Johansson. Even this and the further modifications of Watson Jones, White, and others still demand such a high degree of technical skill and perfection of equipment that the application of the method is limited. It cannot be undertaken except in hospitals which have adequate equipment, and relatively few have the desired armamentarium. It demands perfect coordination between a skilled X-Ray Department and the operating-room staff. The equipment and facilities of smaller hospitals are apt to be inadequate and, therefore, preclude the surgeon from operating "out of town", and the patients will not stand transportation for long distances. Finally, it can only be done with success by a surgeon who is thoroughly familiar with bone surgery and the surgery of the hip joint; it emphatically is not an operation to be performed by the occasional surgeon, or the general surgeon, or, indeed, by anyone not skilled in orthopaedic surgery. These factors greatly limit its application. It is most desirable to achieve further simplification of the method of introducing the nail, so that the method can be more widely applied. Until then, we should not abandon the simpler and more widely applicable abduction treatment of Whitman.

COMMENT

It only remains to be stated that nearly all our failures occurred in the early period of our use of this form of treatment. Further experience has

enabled us to insert the nail with increased speed and facility and with greatly diminished disturbance to the patient. Our experience leads us to believe that, after satisfactory reduction of a fracture, a nail properly placed in the fragments will ensure union in practically every case in greatly diminished time and with great improvement in function. Internal fixation of fracture of the neck of the femur marks a great advance in treatment. Our present attitude is that all fractures of the neck of the femur can best be treated by internal fixation.

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DASHBOARD DISLOCATION OF THE HIP

A Report of Twenty Cases of Traumatic Dislocation *

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The name "dashboard" dislocation of the hip has been chosen because it points out the means by which most of the patients upon whose cases this paper is based received their injuries. The person so injured was usually sitting beside the driver of an automobile when it came to an abrupt stop in a collision. In such a case, since the hip is in a flexed and adducted position, the force of the impact of the tibia or of the knee against the panel is transmitted through the femur to the posterior rim of the acetabulum, and the result may be a simple dislocation or a dislocation with fracture of the lip of the acetabulum. Occasionally a fracture of the tibia or of the patella is experienced instead.

This mechanism was the cause of dislocation in thirteen of the twenty cases here reported. In the remaining seven, two patients were thrown out of automobiles; two were struck by automobiles; one patient fell from a tree; one fell from a box car; and one was injured at birth.

The routine method of treatment in the fresh cases was immediate closed reduction, followed by traction of the Russell or Buck type. If there was a formidable fracture of the acetabulum, the traction was maintained for a period of approximately eight weeks. If, however, no acetabular fracture existed, the period of traction lasted only from two to three weeks. During the period of traction in both instances, active motion was maintained in the knee and the hip joints.

Treatment of the old cases required much more active correction, and the results were discouraging, as shown in Table I.

A brief description of these twenty cases is contained in Table I. The findings may be summarized as follows:

1. The age range of the majority of these patients was between twenty-three and fifty years.
2. There were thirteen males and seven females.
3. Thirteen of the patients were injured while they were riding as passengers in automobiles; in ten of these cases the right hip was dislocated.
4. The average period of observation was three years.
5. In the three cases in which operations were performed the average period between injury and treatment was eight months.

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

6. In eleven cases the end results were good; in two, fair; in five (including the three cases in which operations were performed), poor; and in two, undetermined.

7. In six cases there was absorption of the head.

8. In seven cases there was an uncomplicated posterior dislocation; in one, an uncomplicated obturator dislocation; in one, an obturator dislocation with an incomplete fracture of the neck; in two, fracture of the neck and posterior dislocation; and in nine, posterior dislocation complicated by fracture of the acetabulum.

COMMENT

The following case is typical of the injury under discussion and shows the result when treatment is delayed.

CASE 15. R. S., a boy, aged thirteen, was riding beside the driver of a roadster when the car hit an abutment and overturned. After a brief period of confusion, he got up and hobbled to another car. When he reached his home, the family physician was called. There was evidence of contusion about the right hip, but no shortening or apparent deformity. No roentgenographic examination was made at the time. The boy continued to complain of pain and swelling in the region of the hip, and three weeks after the injury a roentgenogram showed a complete posterior dislocation of the head of the femur (epiphyseal separation), but the neck had sprung back into the acetabulum. Because of the boy's age, an open reduction was done and, after much difficulty, the head was replaced on the neck and then put back into the acetabulum. The head was maintained in its position by means of an ivory peg. Aseptic necrosis of the head took place. Observation five years after injury (Fig. 1) showed shortening of one and one-quarter inches. The ability to abduct and to rotate was greatly limited. However, in spite of the limp, the boy was free from pain and took part in such athletics as tennis and golf.

Two similar cases (Cases 2 and 19) were treated more recently, with poor results. (See Figures 2, 3, 4, 5, and 6.)

Miltner and Wan reported a series of sixteen cases of hip dislocation of long standing in which reduction was accomplished in twelve with a fair percentage of good results. The anterior incision of Smith-Petersen was used in all but one case. However, our experience has caused

FIG. 1

Case 15. Epiphyseal-separation dislocation, five years after open reduction, showing neck in acetabulum.

TABLE I

TWENTY CASES OF TRAUMATIC DISLOCATION OF THE HIP

Case	Sex	Age (*Years*)	Type of Dislocation		Side Dislocated	Cause	Method of Reduction		Time Between Injury and Treatment	Result	Period of Observation
			Simple	Complication			Closed	Open			
1. W. B.	Female	28	Posterior		Right	Riding in car	Immediate. Traction for 6 weeks.		2 hours	Good	2½ years
2. W. C.	Female	43	Posterior	Fracture, with femoral neck in acetabulum	Right	Riding in car	Traction for 2 weeks. Cast for 10 weeks.		4 hours	Poor. Aseptic necrosis.	10 months. Motion fair. Shortening of ⅞ of an inch.
3. C. A.	Female	27	Posterior		Left	Riding in car	Immediate. Traction for 2 weeks. Cast for 4 weeks.		2 hours	Good	9 months
4. D. W.	Male	29	Posterior	Slight fracture of acetabulum	Right	Riding in car	Immediate. Traction for 6 weeks.		24 hours	Good	1 year
5. M. G.	Female	54	Posterior	Fracture of acetabulum	Right	Riding in car	Immediate. Cast for 7 weeks.		5 hours	Good	3 years
6. J. M.	Male	45	Posterior		Left	Riding in car	Immediate. Traction for 3 weeks.		3 hours	Good	4 months
7. H. C.	Female	39	Posterior	Fracture of acetabulum	Right	Riding in car	Traction for 7 weeks.		4 hours	?	8 weeks
8. J. H.	Male	45	Posterior	Fracture of acetabulum	Left	Riding in car	Traction for 6 weeks.		1 hour	Good	5 years
9. D. S.	Male	31	Obturator		Right	Thrown from car	Immediate. In bed for 2 weeks.		4 hours	Good	5 years
10. K. H.	Male	51	Posterior		Right	Hit by car	Immediate. Cast for 7 weeks.		2 hours	Good	2 years

11. J. W.	Male	8	Posterior		Right	Hit by car	Immediate. Traction for 4 weeks.		3 hours	Good	2 years
12. C. G.	Female	45	Posterior	Fracture of acetabulum	Right	Riding in car	Immediate. Traction for 4 weeks. Cast for 4 weeks.		12 hours	Fair	3 years
13. G. G.	Male	63	Posterior	Fracture of acetabulum	Right	Fell from tree	Traction for 8 weeks.		3 hours	Good	4 years
14. D. S.	Male	48	Posterior	Fracture of acetabulum	Right	Riding in car	Immediate. Traction for 6 weeks.		5 hours	Poor. Aseptic necrosis.	6 years. Motion limited. Pain.
15. R. S.	Male	13	Posterior	Fracture, with femoral neck in acetabulum	Right	Riding in car		Ivory pin	3 weeks	Poor. Aseptic necrosis.	5 years. Motion fair. Shortening of 1¼ inches.
16. M. D.	Female	35	Obturator	Fracture, with chip off neck	Right	Thrown out of car	Immediate. Traction.		3 hours	?	5 weeks
17. B. C.	Male	10 days	Posterior		Right	Podalic version	Immediate. Cast for 10 days.		10 days	Good	5 years
18. T. D.	Male	46	Posterior	Fracture of acetabulum	Right	Riding in car	Traction for 10 weeks.		2 weeks	Fair. Aseptic necrosis.	6 months
19. M. M.	Male	46	Posterior		Right	Riding in car		Resection of head. Neck in acetabulum.	15 months	Poor. Aseptic necrosis.	3 months
20. A. H.	Male	23	Posterior	Fracture of acetabulum	Right	Fell from boxcar		Shelf operation	8 months	Poor. Aseptic necrosis.	8 months. Hip partly redislocated.

FIG. 2

Case 2. Posterior fracture-dislocation of the head of the femur; neck in acetabulum.

FIG. 3

Case 2. Ten months after injury. Full range of flexion. Adduction and rotation limited.

us to feel that such an incision creates too great a handicap to the proper shelving of the posterior portion of the roof of the acetabulum.

An analogous case was reported by Henry and Bayumi. The proximal portion of the femur of a woman sixty years of age was removed and the neck was inserted into the acetabulum. These authors stated that three inches of shortening resulted, but they did not mention the range of motion.

Platt pointed out the danger of injury to the sciatic nerve and of fracture of the neck of the femur when manual reduction is attempted more than a few weeks after dislocation. If uncontrollable bone fragments are present at the time of manual reduction, he felt that their removal at operation, six to eight weeks after reduction, improves motion and lessens pain.

Bunne reported a good result in his case, that of a woman forty-four years old, after open reduction of an obturator dislocation, in spite of the presence of myositis ossificans and of some necrosis of the head.

Six of our cases demonstrated the possibility of development of aseptic necrosis, as described by Phemister and by Dyes. Two of the cases reported by Dyes showed changes almost identical with those seen in Legg-Perthes disease. Apparently injury to the nutrient arteries of the neck is necessary, in addition to rupture of the ligamentum teres, for the development of severe necrotic changes.

FIG. 4

Case 19. Dislocation unreduced, fifteen months after injury.

FIG. 5

Case 19. Five weeks after operation consisting of open reduction, decapitation, and replacement of the neck in the acetabulum.

FIG. 6

Case 19. Three months after operation.

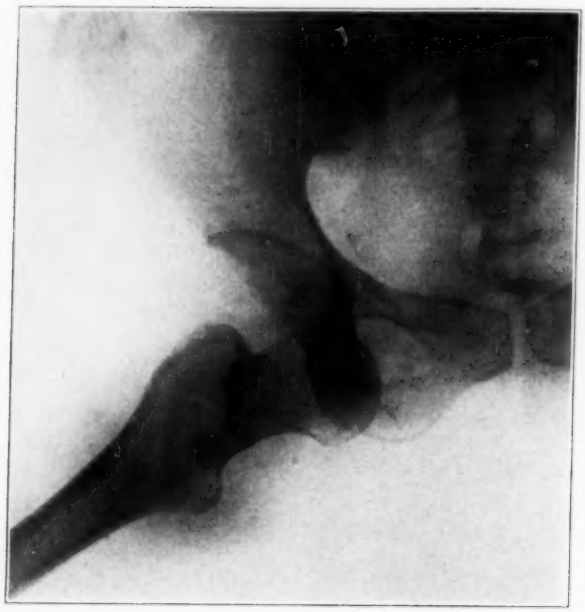

FIG. 7

Case 9. Uncomplicated obturator dislocation.

Stewart reported a case of simple dislocation in which good recovery was apparently being made at the end of two months, but, at the end of five months, there was increasing limitation of motion because of the gradual development of ossification in the capsule and breaking down of the head. The head later became transformed, but at the expense of motion.

This type of degenerative change in the joint took place in one of the cases (Case 14) of this series.

CASE 14. D. S., a physician, aged forty-eight, received a dislocation of the right hip with a fracture of the posterior rim of the acetabulum. Good recovery of function was apparently taking place, but, at the end of four or five months, increasing lameness and pain in the hip developed. Roentgenographic examination showed partial absorption of the head with calcification of the capsule. Transformation gradually took place in the head, but, on observation six years after injury, the patient showed marked limitation of motion of the hip, walked with a decided limp, and had pain.

Our youngest patient (Case 17), a new-born boy, received a traumatic dislocation as a result of podalic version in delivery. This case has been included in the series with apologies to the "dashboard syndrome". The dislocation was upward and backward and was easily reduced under a very short anaesthesia. A cast was applied from the toes to the chest for a period of ten days, and no further treatment was given. The patient was reexamined five years later, and the hip was apparently normal in every respect.

Such dislocation in children is rare, but cases have been reported by Glynn, and Mauck and Anderson. The only other child who came under our observation was a colored boy, aged eight (Case 11). Goetz reported a traumatic dislocation of the hip into the scrotum occurring in a boy ten years of age, and Campbell reported a perineal dislocation in a boy of eleven.

Two of our patients (Cases 9 and 16) had obturator dislocations. In one case (Case 9), the dislocation was uncomplicated by fracture (Fig. 7). In the other (Case 16), a large chip was torn loose from the upper surface

FIG. 9

Case 16. After reduction. Note defect in neck.

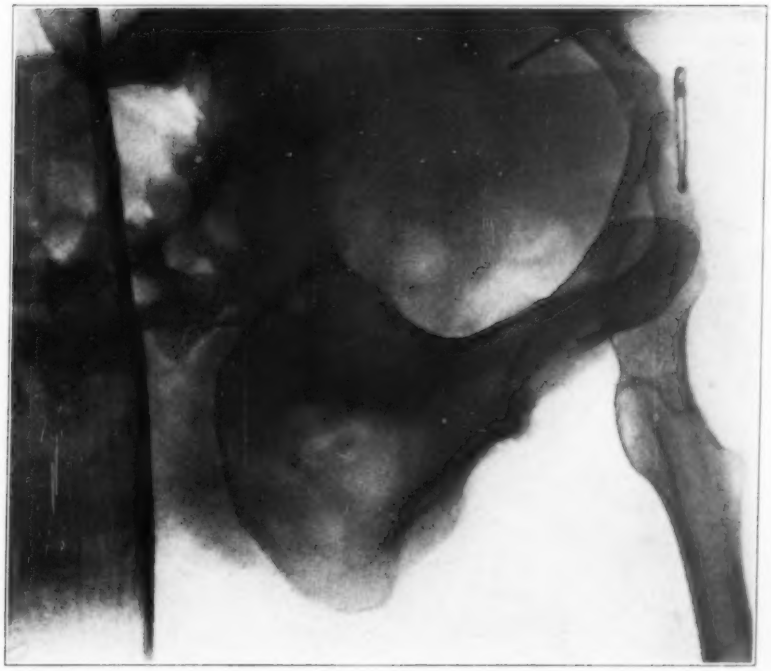

FIG. 8

Case 16. Obturator dislocation with avulsion fracture of the neck.

of the neck, which had apparently been avulsed by the capsule when it became detached (Figs. 8 and 9). Such cases seem to be subject to aseptic necrosis.

CONCLUSIONS

1. The immediate reduction and traction treatment of uncomplicated dislocation of the hip gives uniformly good results.

2. When the dislocation is accompanied by a formidable fracture, the prognosis should be guarded, because of the possibility of development of aseptic necrosis and periarticular ossification.

3. The longer the hip stays out of place the poorer are the prospects of obtaining a satisfactory result by operation.

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THE SPASTIC HAND

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The surgery of the spastic hand is neglected. This has been emphasized by Brockway. In a study of 1000 spastic children, on whom 542 operations had been done, the author found that the upper extremity itself received surgical attention only sixty-five times. The hand, exclusive of the wrist, was operated upon ten times, nine of the operations being directed at the oppositional deformity of the thumb.

This study is the result of clinical observation on the effect of curare in spastic paralysis. It includes the study of persistent spastic opposition position and contracture of the thumb, with or without flexion of the terminal phalanx of the thumb; spastic adduction contracture of the thumb; spastic intrinsic hyperextension of the fingers; spastic flexion-abduction position of the fingers; and, finally, spastic anterior subluxation of the first metacarpal head. A solution was sought for every hand deformity which did not yield to curare or hindered its effects. It is to be emphasized that this is not a final study of end results, since the period of postoperative observation is too short. Most of the cases have been followed for at least a year after operation.

PERSISTENT SPASTIC OPPOSITION POSITION OF THE THUMB, WITH OR WITHOUT FLEXION OF ITS TERMINAL PHALANX

The thumb is drawn into the palm in constant or inconstant position in opposition by the action of the three muscles whose fleshy bellies together make the thenar eminence,—the opponens pollicis, the flexor pollicis brevis, and the abductor pollicis brevis.

The hand encloses the thumb, and it becomes impossible to grasp any object, either passively or actively. In mobile spastics, the passive stretching of the extensors of the thumb in palmar flexion of the wrist sometimes forces the thumb out of the hand, but it reenters the palm on dorsiflexion of the wrist. This is not invariably true, and the thumb may be retained in the palm even though the wrist is in palmar flexion.

The index and middle fingers are sometimes placed more dorsally than the ring and little fingers, because of the indrawing of the thumb. In the presence of frequent spasm of the index finger, the skin over the dorsal aspect of the metacarpophalangeal joint of the thumb may become excoriated and keratotic. Dissociated action of the thenar muscles sometimes exists. The thumb is not opposed. The first metacarpal bone is abducted by the abductor pollicis longus, and the thumb is flexed at the metacarpophalangeal joint by the flexor pollicis brevis, the terminal phalanx being hyperextended.

* Service of Leo Mayer, M.D.

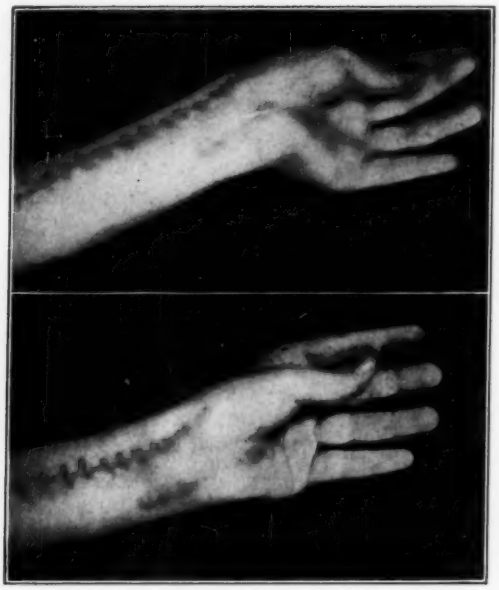

FIG. 1-A

Case G. W., female, aged twenty-two, showing the spastic indrawing of the thumb. This case is not described in the text.

The terminal phalanx of the thumb is often flexed by spasm of the flexor pollicis longus. This flexion increases the positional deformity of the thumb. The flexor pollicis longus acts in the manner of a bowstring as a secondary opponens of the thumb. The thumb executes its final position of opposition easily with flexion of the terminal phalanx. Opposition is more difficult in extension of the terminal phalanx, and, in the normal hand, strain is felt in the short muscles of the thumb in this position. In some spastic thumbs, flexion at the metacarpophalangeal joint of the thumb with extension of the terminal phalanx is seen. This is comparable to the intrinsic-muscle position of a finger. The flexion of the basal phalanx is due to action of the flexor pollicis brevis; the extension need not be an active extension, but may be passive by pull of the fascial band which passes from the abductor pollicis brevis to the extensor pollicis longus. Opposition position of the thumb is not as marked in terminal-phalanx extension.

The *position in opposition* can in time become *contracture in opposition*. The author has noted this twice. This contracture in opposition is present only in the older spastics in whom the deformity has existed for many years. The atrophied muscles have long ceased to respond to hyperinnervational impulses. The first metacarpal bone is drawn in front of the second metacarpal and is more or less immovable in that position, not only by muscle contracture but also by contracture in the carpometacarpal joint of the thumb. An unusual complication is medial rotation of the thumb by pull of the thenar muscles, when a fixed anterior subluxation of the first metacarpal head exists. The thumb is so twisted that the nail faces the palm and the pulp of the thumb faces outward.

There have been many operative attempts to correct persistent opposition position of the thumb. Dowd noted that Hoffa shortened the extensor pollicis longus. This operation is comparable to the tendon transplantation of Biesalski and Mayer, in which the extensor indicis proprius is attached to the long extensor of the thumb. Vulpius and Stoffel shortened the abductor pollicis longus. Hoffa transplanted the

flexor carpi radialis to the extensor pollicis longus to secure active abduction of the thumb. He also shifted this same tendon to the abductor pollicis longus, together with one-half of the extensor carpi radialis, for the same purpose. The Stoffel operation has been recommended not only by Stoffel but by other authors, such as Gill and Heyman. This operation is not now usually done, but Brockway does a complete or partial resection of the nerve supply to the opponens pollicis or flexor pollicis brevis, with a fair end result.

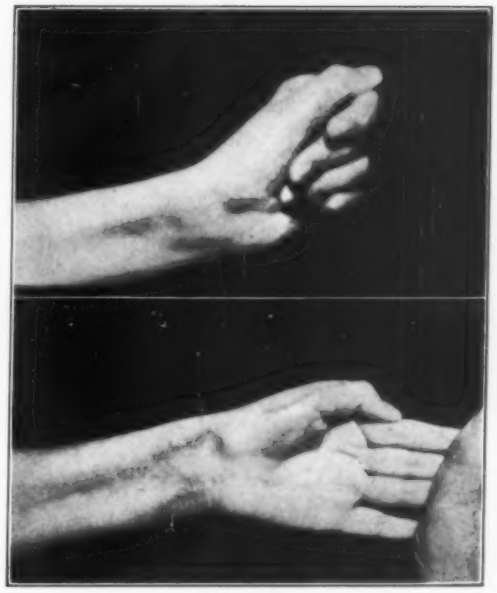

FIG. 1-B

Case G. W. The appearance of the thumb after operation.

Foerster and, later, Silfverskiöld did a tenomyotomy of the muscles which terminate on the ulnar sesamoid of the thumb, or a myotomy of the opponens pollicis. The adductors seem to have been cut also. Silfverskiöld used this method with good results. This operation is comparable to the one which the author is describing, but both Foerster and Silfverskiöld placed undue emphasis on the adductors of the thumb. The writer's plan of operation was independently conceived and only in the investigation of the literature did he come upon their work.

The aim of the operation is the lessening of the leverage which the spastic muscles exert on the thumb by the stripping of the common tendon of insertion, with or without plastic lengthening of the flexor pollicis longus at the wrist.

The operation should be a final procedure rather than an initial one,—final in the sense that other operations, such as tendon transplantation at the wrist, precede it. This is so for two reasons: First, we must allow the spastic hand enough time for readjustment after an operative procedure to determine how much has been gained and what is next needed; second, the position of the thumb may change in varying positions of the wrist. The operative procedure for the thumb cannot be carried out until the final position of the wrist is determined. This is not so easy, since many spastics use their fingers better in palmar flexion of the wrist.

Operative Technique

The operation is best done under local anaesthesia. The incision is longitudinal, placed on the anterior radial border of the thumb, and

extends from one-half an inch above the point of thenar insertion down along the length of the shaft of the first metacarpal bone. The superficial branch of the radial nerve is avoided. The opponens pollicis is stripped subperiosteally from the shaft of the first metacarpal. The common tendon is exposed as it inserts diagonally on the prominent tubercle on the outer side of the first phalanx. The tendon is severed from its point of insertion and stripped proximally for at least three-quarters of an inch. It is important that the most ulnar part of the tendon, contributed by the flexor pollicis brevis, be severed. The capsule of the metacarpophalangeal joint may be cut if contracted, and the joint may be opened. The common tendon, which is from one-half to three-quarters of an inch long, is excised after it has been stripped. The wound is closed in layers. The thumb is immobilized in abduction and extension in the plane of the hand for three weeks.

Plastic Lengthening of the Flexor Pollicis Longus at the Wrist

It is simplest to lengthen the tendon at the wrist, above the tendon sheath and near the musculotendinous junction. The tendon can be picked up through a one-inch longitudinal incision above the wrist joint. The tendon of the flexor carpi radialis acts as a guide. It is not necessary to isolate the median nerve, although the author has done so. The tendon is deep in the wrist, and is a peculiarly elusive tendon to find. It lies about midway between the tendon of the flexor carpi radialis and the pronator quadratus; it is nearer the former than the latter. It is lengthened by a Z-shaped incision, the ends being secured by a Bunnell-Mayer stitch. The wound is closed in layers.

In the presence of very marked spasticity, the question of how much to lengthen this tendon becomes a matter of judgment, especially in spasticity of the intermittent, surging type. *It is better to lengthen the tendon too little than too much.* The reverse deformity of *spastic hyperextension of the thumb* is brought about, and, in the period of irritability following the readjustment of the spastic hand, the overactive and unopposed extensors of the thumb can cause a forward subluxation of the head of the first metacarpal. This complication is prevented by immobilization of the thumb in slight flexion. When this complication is present, a splint, holding the thumb in abduction and in slight terminal flexion, with pressure dorsally against the anteriorly protruding metacarpal head, should be applied as long as necessary. This complication is ultimately overcome in full or in part by readjustment of the flexor-extensor balance.

The author has done the operation of thenar stripping eight times. A ninth case was done on the service of Dr. Finkelstein, in which, in addition to thenar stripping, the flexor carpi radialis was transplanted to the abductor pollicis longus. The result is too recent to estimate yet.

The patient may be able to abduct the thumb actively immediately after the operation, whereas before operation this action had never been

FIG. 2-A

Case A. O., female, twenty-four years of age, before operation.

FIG. 2-B

Case A. O., after operation. A flexion position of the terminal phalanx of the thumb has recently developed. The thumb is kept out of the palm.

possible. However, as a rule, the operation gives no active power of abduction unless the abductor pollicis longus has some strength. If a tendon transplantation which will give abduction can be done, it should be done in combination with the operation of thenar stripping. A good result may be expected if the transplanted tendon has actual power; usually, the transplant is paretic. The appearance of the hand after thenar stripping is nearer the normal and the thumb no longer falls into the palm. It is maintained at the side of the hand somewhat ahead of the fingers. In the irritable spastics, the thenar muscles contract as frequently as before operation, but, since the insertion point has been lowered, they do not draw the thumb into the palm.

There has been no recurrence of deformity in any of the cases in which the operation has been done.

Certain minor complications must be avoided. If the joint capsule is opened, there may develop slight restriction of flexion of the metacarpophalangeal joint of the thumb with pain over its anterior capsule. This may persist for several months. If the thumb is immobilized in too much extension, a slight anterior subluxation of the first metacarpal head may take place. In a mobile spastic hand, a mild degree of valgus deviation of the thumb may come about.

A long period of physiotherapy follows the operation and this is supplemented sometimes with curare. Hand exercises are beneficial.

Illustrative Cases

T. G., a girl of nineteen, had a left hemiplegia of syphilitic etiology. The left hand showed spastic indrawing of the thumb with terminal-phalanx flexion. The fingers were clenched over the thumb. The wrist was acutely flexed. The hand showed no active power. Thenar stripping of the left thumb, with lengthening of the flexor pollicis longus at the wrist, was first done, followed several months later by lengthening of the wrist flexors.

The period of observation has been more than a year. There still is no active power in the hand. The thumb is out of the palm and shows no tendency to be drawn into it. It rests usually at the side of the hand and a little in front of it. The terminal phalanx of

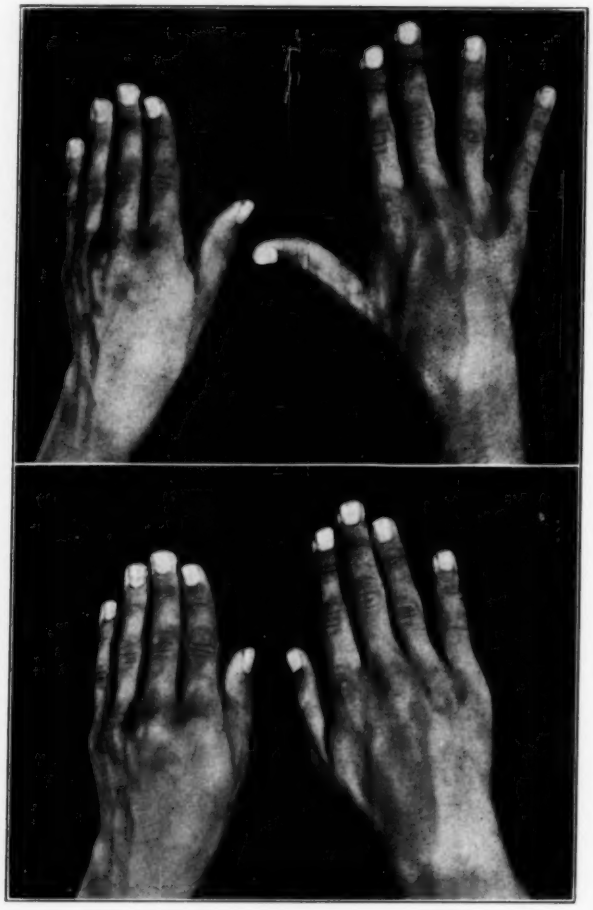

FIG. 3-A

Case S. E., male, sixteen years of age, showing spastic adduction contracture of the left thumb. The power of voluntary abduction is illustrated above, that of voluntary adduction below.

the thumb is held in about 5 degrees of flexion. There is no tendency to reverse deformity of hyperextension of the terminal phalanx of the thumb, since the extensors have neither intermittent spasm nor power. The wrist is held in 160 degrees of palmar flexion. The fingers respond to continuous stretching, but become flexed again after release of the stretching force. The appearance of the hand is improved from a cosmetic standpoint, although there is very little functional use of the hand.

A. O., female, twenty-four years old, had a fixed opposition contracture of the right thumb of many years' duration. (See Figure 2-A.) The thumb could be passively abducted a little, but this caused an anterior subluxation of the first metatarsal head.

On May 13, 1936, the deformity was corrected by the stripping operation with the addition of a capsulotomy of the carpometacarpal joint.

The patient was last seen in November 1936. The thumb rested at the side of the hand just anterior to the palm. Flexion of the terminal phalanx of the thumb was developing and was a little troublesome, since the thumb got in the way of the index finger. (See Figure 2-B.) The flexed wrist had been arthrodesed.

SPASTIC ADDUCTION CONTRACTURE OF THE THUMB

Adduction contracture of the thumb is due to contracture of the first dorsal interosseous muscle and the adductor pollicus obliquus and the adductor pollicis transversus. *It is a contracture in the plane of the hand,* and the thumb does not lie anterior to the palm. It represents expression of increased spasticity in the area of distribution of the motor branch of the ulnar nerve. It may thus be coincident with an intrinsic position of the fingers, the metacarpophalangeal joints being in flexion and the

proximal interphalangeal joints in extension. The spasticity is uneven and is greatest in the thumb adductors, or it may be an isolated expression of ulnar-nerve spasticity.

The disability resulting from adduction contracture is twofold. The thumb cannot be abducted in the plane of the hand to encircle an object. The tight adductors restrict the ability of the thumb to oppose, so that it may be possible only to bring the thumb to the index finger.

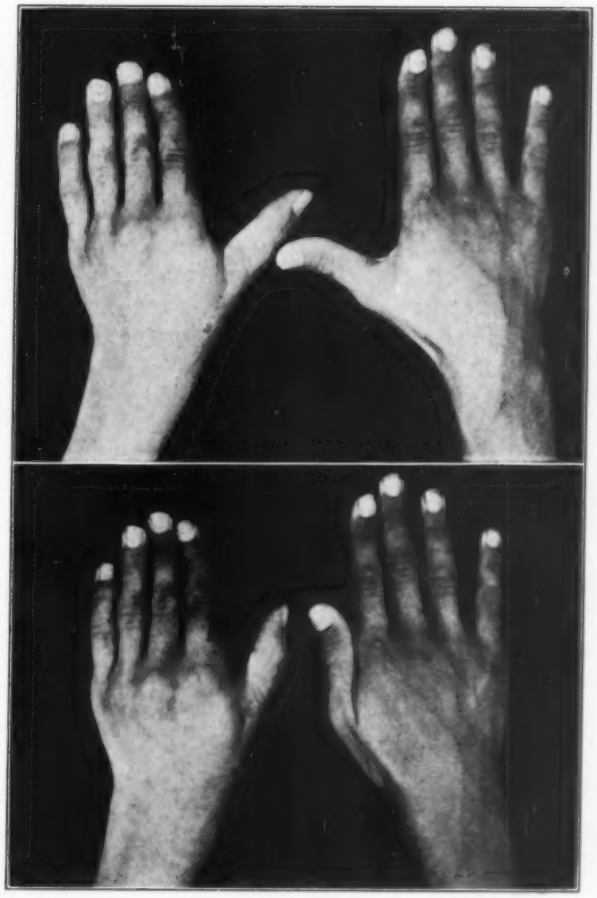

FIG. 3-B

Case S. E., after operative correction of the deformity of the thumb. The voluntary abduction is shown above, adduction below.

The contracture is quite uncommon, but probably more common than is suspected. The author has found only one reference to this condition. Vulpius and Stoffel have noted that in adduction contracture of the thumb an open section of the adductors is to be done. The adductors are approached by a volar transverse incision.

Operative Technique

A longitudinal incision is made, running parallel to the shaft of the first metacarpal bone along its ulnar border. It extends about one-half an inch above the tubercle insertion of the adductors and runs the entire length of the metacarpal. The tendon of the extensor pollicis longus is retracted laterally in the outer margin of the wound. A digital branch of the radial nerve, which courses obliquely upward and medially from the lower angle of the wound, is avoided. The first dorsal interosseous muscle is stripped subperiosteally from the shaft of the first metacarpal. The combined tendon of insertion of the two adductors is seen in the bottom of

the distal part of the wound. Section of the tendon between clamps is carried close to the bone. This overcomes the adduction contracture. Care should be taken in section of the adductors, since just anterior to them and separated from them by a thin but distinct fascial plane lies the principal artery of the thumb. The long flexor of the thumb is still more anterior. The wound is closed in layers and the thumb is immobilized in full abduction in the same plane of the fingers. Gauze-pad pressure is made anteriorly and posteriorly to the web of the thumb to prevent postoperative hematoma. Immobilization is maintained for about three weeks, when exercises are begun.

The author has corrected adduction contracture of the thumb in two cases. In one, the intrinsic-muscle imbalance * of the fingers was absent, and in the other it was so slight that resection of the motor division of the ulnar nerve could not be considered. The result in both cases was good. Active abduction and adduction were attained. There is early reformation of the adductors, even at three weeks after operation, so that inability to adduct the thumb need cause no worry. Thenar opposition was still limited in one case; in the other it was good.

Illustrative Case

S. E., a boy of sixteen, showed an adduction contracture of the left thumb (Fig. 3-A). Abduction of the thumb in the plane of the hand was greatly lessened. On August 14, 1935, under general anaesthesia and with the use of the tourniquet, the operative release of the deformity was done. The postoperative course was uneventful, and the wound healed *per primam.* (See Figure 3-B.) The patient was seen last on May 9, 1936. Good adduction and abduction of the thumb, especially passively, were present. Reformation of the adductors had taken place, so that the power of adduction of the thumb was not lost. The patient demonstrated a mild intrinsic position of the fingers.

SPASTIC HYPEREXTENSION OF THE FINGERS IN INTRINSIC-MUSCLE IMBALANCE

Hyperextension of the proximal and distal interphalangeal joints is associated with flexion of the metacarpophalangeal joints in intrinsic-muscle imbalance. In extensor spasm, which is not usual, there is extension of the fingers also, but extension, rather than flexion, at the metacarpophalangeal joints. It is not uncommon to observe the intrinsic position in mobile spastics, but this position is a changing one. Fixed deformity can occur, and for this Steindler resected the motor branch of the ulnar nerve. The average spastic hand seldom exhibits that great degree of hyperextension sufficient to warrant operative interference. Not every hand in spastic intrinsic imbalance is useless, for a mild degree may allow active hand power and require no operation. The degree of deformity of this type of hand may fluctuate, or the deformity may shift intermittently,

* The term "intrinsic-muscle imbalance" refers to an imbalance existing between the extrinsic and intrinsic muscles, in favor of the intrinsic muscles. The fingers assume a position of flexion at the metacarpophalangeal joints and extension at the interphalangeal joints. Abduction or adduction of the fingers may be present in the intrinsic position, depending on the preponderance of power in either dorsal or volar interossei.

so that the fingers may be clenched or extended. The obliquely coursing collateral extensor tendons stand out as taut bands beneath the skin in intrinsic or extensor spasm. The wrist is palmarly flexed or fused in dorsal position, or it alternates between dorsiflexion and palmar flexion. No "pill roller" hand was observed, and the observation of Steindler that the deformity can only exist in dorsiflexion could not be substantiated. Spastic intrinsic-muscle imbalance was present in hands whose wrists were either dorsally or palmarly flexed, although the intrinsic-muscle position is more easily taken in dorsiflexion of the wrist.

The operative procedure consists in the proximal stripping of the collateral extensor tendons to the mid-part of the first phalanx, a point well below the hyperextended joint. The common extensor tendon must be cut transversely or lengthened, for, if this is not done, recurrence of the extension deformity will take place. There is a certain sympathy in spastic hands by which an operative procedure directed at one point diminishes spasticity at another point. The author, therefore, has confined the operation to the usually more severely affected index and middle fingers, believing that release of hyperextension of these fingers would diminish the hyperextension of the fourth and fifth fingers. Clinically, he has noted that hyperextension is greatest in the index finger and diminishes progressively to the little finger.

The stripping must be thorough. If it is incomplete, an unusual position of the finger is assumed. The proximal interphalangeal joint goes into a lesser hyperextension than before operation, while the terminal phalanx is flexed because of the action of the now stronger flexor profundus tendon. This is a position which can only be assumed voluntarily by a normal finger as a trick motion. The index finger may rest in a plane higher than the middle and other fingers after operation. The writer believes that this is due to the presence of two extensor tendons to the index finger. He has observed only once the little finger of a spastic hand in a plane higher than the ring and middle fingers; it was on a line equal with the index finger.

The proper end result should be a more even balance between flexion and extension of the finger.

Operative Technique

Two incisions are made on each finger,—one placed radially and one ulnarly. The incision begins at about the mid-part of the second phalanx, and runs obliquely and proximally in the line of the collateral extensor tendon to about the mid-part of the first phalanx. Each collateral tendon is identified, severed transversely distally, and stripped proximally. The entire tendinous band is removed at the mid-part of the first phalanx, below the proximal interphalangeal joint. False dissection must be avoided. The thin central fascial extension over the second phalanx is untouched, and it is through its action that extension is hoped for. The common extensor tendon is sectioned transversely at the level of the

FIG. 4-A

Case E. F., a girl of fourteen, with a left hemiplegia. The extreme intrinsic hyperextension of the fingers is shown above. The thumb is kept out of the palm after a thenar stripping as shown below.

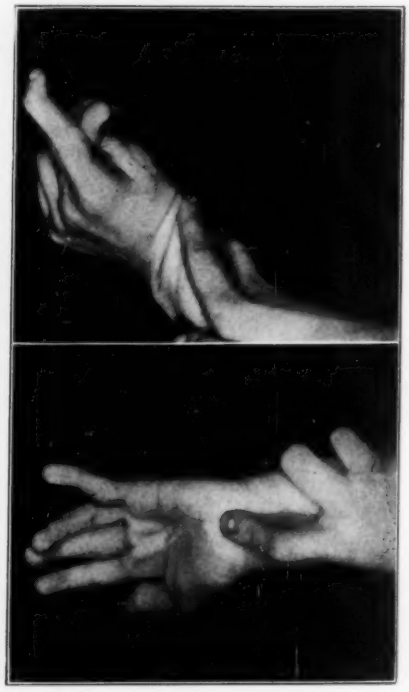

FIG. 4-B

Case E. F. The photograph below shows the opened hand, with the wrist held passively in dorsiflexion; that above shows the peculiar flexion position of the terminal phalanx of the index finger after incomplete division of its extensors. The thumb is out of the palm, but its terminal phalanx is in hyperextension following a lengthening of the flexor pollicis longus.

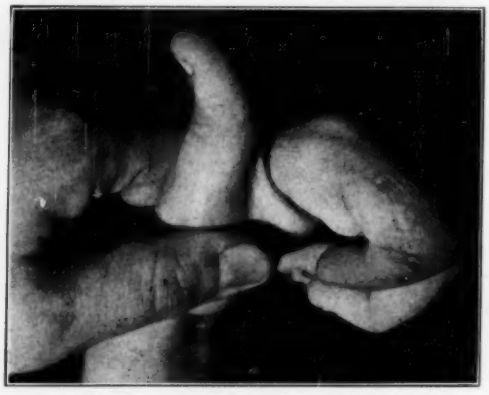

FIG. 4-C

Case E. F. The appearance of the index finger after reoperation upon the extensors.

proximal interphalangeal joint. It slips back about three-eighths of an inch, but further retraction is not allowed, since it is held in the extensor aponeurosis. The wound is closed, and the finger is bandaged in flexion.

Illustrative Case

The left hand of E. F., a girl fourteen years old, showed an extreme intrinsic spastic hyperextension deformity of the fingers and spastic indrawing of the thumb into the palm with terminal-phalanx flexion. (See Figure 4-A.) On April 24, 1935, a thenar stripping was

done under local anaesthesia. On August 21, 1935, the flexor pollicis longus was lengthened, and the collateral extensor tendons of the index and middle fingers were stripped. (See Figure 4-B.) It was necessary to reoperate on the index finger, since hyperextension of the proximal interphalangeal joint was still present. This was done on April 1, 1936, and the common extensor tendon was cut transversely at the level of the proximal interphalangeal joint. (See Figure 4-C.)

The patient was last examined in September 1937. The thumb was kept out of the palm. The terminal phalanx of the thumb was usually in some hyperextension. A mild valgus deviation of the thumb (pollex valgus) was noted, with protrusion of the head of the first metacarpal radially. This was due to opening of the lateral joint capsule and to the bowstring action of the medially displaced long extensor tendon. The index and middle fingers were flexed, especially by the action of the flexor sublimis. A certain amount of extension of the fingers was allowed, so that the patient used the hand better as a support when eating or doing ordinary work.

SPASTIC FLEXION-ABDUCTION POSITION OF THE FINGERS

Spastic flexion-abduction position of the fingers is maintained by a spasticity of the interossei dorsales in excess of the interossei volares. The author has not seen spastic contracture in flexion-adduction of the fingers.

Illustrative Case

F. B., male, thirty-seven years of age, has a residual disability of the left hand following a sudden stroke on December 27, 1934. This disability is a spastic intrinsic flexion-abduction position of the fourth and fifth fingers. (See Figures 5-A and 5-B.) The fingers are flexed at the metacarpophalangeal joints and extended at the proximal interphalangeal joints. They are also abducted and cannot be adducted in the intrinsic position. The middle finger is in neutral position, and the index finger is held in extension at the metacarpophalangeal joint and in slight flexion at the interphalangeal joints. The patient has a fair amount of strength in the hand, but the grip cannot be

FIG. 5-A

FIG. 5-B

Case F. B., male, thirty-seven years of age, showing the spastic flexion-abduction position of the fingers.

maintained. He can pick up vertically placed objects only by cupping his hand.

The disability of his hand is due to a spastic imbalance of the intrinsic muscles of the hand in favor of the interossei dorsales. Most of the spasticity is confined to the distribution of the motor branch of the ulnar nerve. This nerve was injected with novocain, the injection being made between the pisiform and hamate bones, with resultant ulnar-nerve hypaesthesia and a feeling of looseness in the affected fingers. The reverse deformity was not produced. The stripping of the affected interossei dorsales has been recommended.

SPASTIC ANTERIOR SUBLUXATION OF THE HEAD OF THE FIRST METACARPAL BONE

This is a not uncommon subluxation of the spastic thumb and is due usually to overpull of the long and short extensors of the thumb, so that, by a bowstring action, the head of the first metacarpal is forced forward. It may be due in some cases to pull of the flexor pollicis brevis, but this is less usual as an etiological factor. It is not surprising that such a subluxation may develop, since it may be present in the normal hand as a trick motion by extensor action in loose-jointed individuals. Rarely, it may exist as a fixed deformity. It is ordinarily not an isolated phenomenon in spastic paralysis and is almost always associated with thenar-muscle spasm. It may develop after operation in a patient in whom it has not existed before. In a spastic mobile hand, it will surely come on after lengthening of the flexor pollicis longus. The balance of power then swings over to the extensor side of the thumb. It may develop in a non-mobile spastic hand after stripping of the thenar muscles, if the metacarpophalangeal joint has been opened and the thumb immobilized in slight extension. Therefore, after these procedures care should be taken to put pressure dorsally upon the head of the first metacarpal, either by splint or by plaster.

COMMENT

In this consideration of the spastic hand from a kinesiological viewpoint, especial emphasis has been placed on those constant elements in spastic position which are conditioned by spasticity of the intrinsic muscles. The extrinsic spastic hand has not been considered, since the author has observed only one case of extrinsic hyperextension deformity of the fingers.

The operative procedures described for the correction of spastic opposition position or contracture of the thumb, spastic adduction position of the thumb, and marked intrinsic hyperextension of the fingers are not intended to be complete in themselves as a form of therapy. They are only aids in the treatment of a hand whose spasticity should be relieved by curare and whose education should be lifelong.

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SPASTIC INTRINSIC-MUSCLE IMBALANCE OF THE FOOT

RESECTION OF THE MOTOR BRANCH OF THE LATERAL PLANTAR NERVE FOR INTRINSIC-MUSCLE CONTRACTURE

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Spasticity of the intrinsic muscles of the foot results in flexion of the toes at the metatarsophalangeal joints and extension or hyperextension at the interphalangeal joints. There may be fixed contracture or mutable position of the toes. The great toe is flexed at its metatarsophalangeal joint by pull of the flexor hallucis brevis and extended at the interphalangeal joint.

This deformity of the foot corresponds to the more common spastic intrinsic-muscle deformity of the hand. In the hand, it is the motor branch of the ulnar nerve which innervates the intrinsic muscles; in the foot, it is the motor branch of the lateral plantar nerve by which these muscles are innervated. This nerve supplies all the interossei except those in the fourth intermetatarsal space, which have their own little twig from the proper digital nerve of the superficial branch of the lateral plantar nerve. The first interosseous dorsalis muscle often receives a twig from the medial branch of the deep peroneal nerve; the second interosseous dorsalis muscle, from the lateral branch of the same nerve. The second, third, and fourth lumbricales and the adductor hallucis are also

* Service of Leo Mayer, M.D.

supplied by the motor branch. The first lumbricalis and the flexor hallucis brevis are innervated by branches from the medial plantar nerve.

Sometimes the action of the intrinsic and extrinsic muscles is not coordinated, so that one or more of the toes may be in the intrinsic position and the others in the extrinsic position. This is found in mobile spastics, especially in dystonics.

It is the poor pivotal support of the toes which makes walking and standing difficult that makes necessary some form of operation in fixed intrinsic contracture of the foot. Resection of the motor branch of the lateral plantar nerve, plus plantar capsulotomy of the metatarsophalangeal joint of the great toe and section of the heads of insertion of the flexor hallucis brevis, is the operation of choice. Resection of part of the posterior tibial nerve at the level of the internal malleolus is also to be considered.

The development of the contracture is theoretically hindered by an equinus position of the foot, which creates a passive insufficiency of the dorsiflexors of the foot.

TECHNIQUE OF THE OPERATION

The bony landmark is the styloid tuberosity of the fifth metatarsal bone. A four-inch longitudinal incision, which begins about three-quarters of an inch proximal to the styloid tuberosity, is made on the sole

FIG. 1-A

FIG. 1-B

H. K., before operation. The toes are sharply flexed at the metatarsophalangeal joints and hyperextended at the interphalangeal joints. An equinus deformity of the foot is present.

of the foot in the groove which indicates the line of separation between the central and lateral compartments of the sole of the foot. The lateral plantar nerve runs obliquely, distally, and laterally in the proximal part of the wound, a little proximal to the line of the styloid tuberosity of the fifth metatarsal. The nerve lies beneath the plantar fascia, between the flexor digitorum brevis and the quadratus plantae muscles. These muscles need not be isolated. The tendency is to cut too deeply, whereby both nerve and vessels may be severed at their point of proximal bending. The lateral plantar artery lies just proximal to the nerve at the point of bending of the nerve. Distal to this bend, the nerve runs in the space between the central and lateral compartments. The nerve is dissected out and the motor branch and the twig to the fourth interosseous space are isolated. The motor branch is placed dorsomedially on the common trunk of the nerve before its division. The twig to the fourth interosseous space arises from the proper digital branch to the fifth toe. The branches, once identified, are cut, and the wound is closed in layers.

The plantar aspect of the metatarsophalangeal joint of the great toe is approached by a medial longitudinal incision. Both heads of the flexor hallucis brevis are cut, and the plantar capsule is opened. An incision in the plantar crease of the great toe is made distal to the metatarsophalangeal joint. In the following case, this approach was not used, and a longitudinal incision over the ball of the toe was made. This is not a satisfactory incision.

FIG. 2

H. K., after operation. This picture was taken before the patient's discharge from the hospital in the early part of October 1936, showing the appearance of the toes after resection of the motor branch of the lateral plantar nerve and the twig to the fourth interosseous space. A plantar capsulotomy of the metatarsophalangeal joint of the great toe was also done, together with section of the heads of the flexor hallucis brevis. This improvement has persisted and was so noted at the patient's last examination on October 17, 1937, fourteen months after operation. The appearance of the toes now is as seen in this picture.

CASE REPORT

H. K., male, aged thirty-five, was admitted on March 3, 1936, for the correction of multiple deformities due to spastic paraplegia. The deformities of the right hip and knee were corrected. The results of these operations were good. Accurately fitting braces were applied, but walking with braces and crutches was very difficult because of lack of training and a deformity of the toes of the right foot which gave no pivotal support to the foot. The toes were flexed sharply at the metatarsophalangeal joints and hyperextended at the interphalangeal joints, in fixed contracture. The terminal phalanx of the fifth toe was flexed rather than extended, probably by shoe pressure. The great toe was flexed at the metatarsophalangeal joint and extended at the interphalangeal joint in fixed deformity. An equinus deformity of the right foot was present. There was no active muscle power in the right foot. The toes of the left foot were in a fairly neutral position.

On April 5, 1936, five cubic centimeters of 2-per-cent.-

novocain solution was injected into the sole of the right foot in the region of the motor branch of the lateral plantar nerve. Hypaesthesia of the fourth and fifth toes followed. The hyperextension of the fourth and fifth toes gave way to a more neutral position of the toes; that of the second and third toes was not so markedly diminished. There was no hyperextension at the metatarsophalangeal joints, and the exact amount of flexion at these joints was hard to determine because of oedema of the dorsum of the foot, following capsulotomy of the knee joint. The toes could be manually flexed, a movement not previously allowed.

On August 25, 1936, resection of the motor branch of the right lateral plantar nerve and the operative procedure on the right great toe were done. The twig to the fourth interosseous space was isolated and cut. Electrical stimulation of the nerves before resection gave no movement of the toes. The wounds healed normally. On September 11, 1936, manipulation of the right foot was done. The toes were brought into neutral position after each joint of the toes had been separately manipulated. Many adhesions were heard snapping. It was difficult to correct the flexion contracture of the second and third toes at the metatarsophalangeal joints. The great toe was also manipulated. The foot was brought into 85 degrees of dorsiflexion. The left foot needed no operative procedure.

The patient was then transferred to a city hospital and later to a convalescent home in Connecticut where he was last seen on October 17, 1937. The follow-up period of about fourteen months is a sufficient length of time to estimate the end result.

In view of the joint contractures, it was not expected that a complete reversal of position could take place, and this was indicated by the test of novocain injection. The operative procedure could not interrupt the nerve supply to the first lumbricalis or to the flexor hallucis brevis, nor could it affect the deep peroneal supply of the first and second interossei dorsales. It took a certain length of time for the alteration of position of the toes to be brought about in the presence of fixed contracture of the toes. It reached its maximum after manipulation of the toes, which loosened up the joints enough for moderate reversal of position.

The right foot is still held in equinus of 120 degrees. The scars on the sole of the foot healed normally and are not painful on weight-bearing. The position of the toes is greatly improved. The fourth and fifth toes show slight flexion of the interphalangeal joints and neutral position at the metatarsophalangeal joints. The second and third toes are still slightly extended at the interphalangeal joints and slightly flexed at the metatarsophalangeal joints. The toes are still stiff and somewhat tender on manipulation. A limited amount of motion, not exceeding 5 to 10 degrees, is allowed. The great toe shows better position. There is flexion at the metatarsophalangeal joint of 165 to 170 degrees, and the interphalangeal joint is in 185 degrees of extension. The patient can walk with braces and crutches for at least half a block. The correction of the equinus deformity of the foot, proper adjustment of the braces, and training in crutch walking should increase his ability to walk.

THE RÔLE OF THE DISCUS ARTICULARIS IN COLLES' FRACTURE

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ANATOMY

The function of pronation and supination of the forearm is of enormous importance, and its loss or impairment causes grave disability. The ulna plays a purely passive rôle in this motion, serving as a fixed point about which the radius moves. The proximal and distal radio-ulnar joints which are concerned not only must permit the full range of motion, but also must maintain the bones in secure apposition throughout this range. Proximally this purpose is served by the cylindrical end of the radius securely held to the ulna by the annular ligament which is attached to the anterior and posterior margins of the lesser sigmoid articular concavity. At the distal end, the roughly quadrilateral radius presents on its mesial aspect a smooth concave surface for articulation with the ulna. The ulna presents a cylindrical articular surface for about two-thirds of its circumference (Fig. 1). This articulates smoothly with the lower end of the radius throughout the full range of its motion. The security of this joint is assured by the discus articularis, or triangular ligament. This structure lies between the head of the ulna and the proximal row of the carpus as a thick, fan-shaped, fibrocartilaginous plate, attached by its apex to the depression at the base of the ulnar styloid. From this point the fibers fan out to become attached to the curved sigmoid edge of the radius. It should be noted that the sigmoid surface forms an arc facing medially and that the motion of the radius about the ulna follows the prolongation of this arc. The locus of points equidistant from this arc—namely, the center of the circle of which the arc forms a part—is represented by the point of attachment of the discus articularis to the ulna (Fig. 1). Thus in the normal wrist this ligament remains tense in any position of the joint. Other ligaments, notably the capsular ligaments and the ligaments of the wrist joint itself, undoubtedly strengthen the

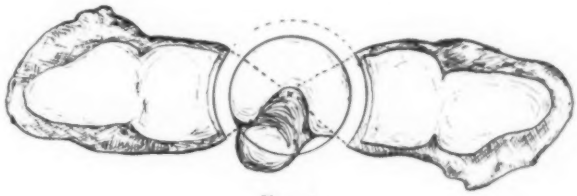

FIG. 1

Distal end of ulna and radius in pronation (left) and supination (right). Note the arc of motion of the radius about the ulnar head. The point of attachment of the discus articularis (*x*) is at the center of the circle of which the arc forms a part. From this point the fibers of the ligament fan out radially to attach to the edge of the sigmoid cavity, as shown by the dotted lines.

joint at various points of its motion, notably at the extremes, although obviously they must be lax enough to permit the full range of motion to take place. The discus articularis is unique in stabilizing the joint in any position whatsoever. The distal surface of the ulna is covered with articular cartilage to permit the ligament to glide over it. The carpal surface of the ligament prolongs the articular surface of the distal end of the radius for articulation with the proximal row of the carpus in the wrist joint.

COLLES' FRACTURE

It is probable that the discus articularis suffers some damage in any injury severe enough to result in a fracture of the distal end of the radius. In most instances, the degree of injury to the ligament does not destroy its function of maintaining the integrity of the radio-ulnar joint. In certain more severe fractures, the ligament may be ruptured, or avulsed from its attachment to the radius or ulna, with or without a fragment of bone (Fig. 2). It is our contention that the successful management of Colles' fracture is in large part dependent on the integrity of the radio-ulnar joint, which in turn depends upon an intact discus articularis. In considering treatment, we find it helpful to divide our group of Colles' fractures into two main classifications:

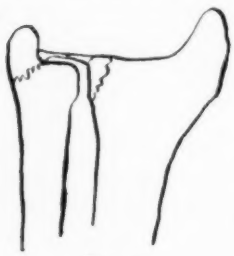

FIG. 2

Anteroposterior view of both bones at the wrist, showing the attachments of the discus articularis. Note that fractures occurring through the base of the ulnar styloid or through the medial aspect of the radius permit loss of integrity of the radio-ulnar joint. This may also occur through rupture or avulsion of the ligament without an attached bone fragment.

1. Fractures with the discus articularis intact.
2. Fractures with loss of integrity of the radio-ulnar joint, due to:
   a. Rupture of the ligament itself.
   b. Avulsion of the ulnar styloid at its base.
   c. Severe comminution of the lower end of the radius with the ligament attached to a loose minor medial fragment.

In the first group, despite displacement, comminution, and impaction, the problem is a relatively simple one. The intact radio-ulnar joint serves as a fixed point around which to reconstruct the normal anatomy. In the second group, the distal fragment moves with the carpal bones as one unit, while both bones of the forearm move as another unit and with little relation to each other. A proper reduction and fixation under such conditions becomes a complicated problem for there is no fixed point around which to build either the reduction or the fixation. It is with this second group of cases that we are here concerned. While recognition of the complicating injury may be difficult, proper treatment of the fracture depends upon distinguishing these cases.

DIAGNOSIS

The typical deformity of Colles' fracture involves some degree of supination of the distal radial fragment in relation to the shaft of the bone. This in itself is responsible for the loss of the dorsal prominence of the ulna which is present in the normal wrist in pronation. If the integrity of the radio-ulnar joint has been lost, the ulnar head lies much farther forward, even presenting as a bulge on the volar aspect of the wrist. In addition, it will be found to be abnormally movable in relation to the radius and to the hand. It also often presents as a distinct prominence on the medial aspect of the wrist, where it is responsible for the abnormal broadening which is characteristic of the severer fractures. Marked forward or medial displacement of the ulnar head, combined with abnormal mobility, is the chief clinical evidence of a loss of the joint integrity. In addition, there is more pain on attempt to carry out pronation and supination than in the case of a simple Colles' fracture. Roentgenographic evidence confirms the separation of the ulnar head from its relation with the distal radial fragment, and a lateral view usually shows the marked forward displacement of the head. In the diagnosis of simple rupture of the ligament uncomplicated by fracture—a very rare injury—it may be necessary to take roentgenograms at various positions of pronation and supination to reveal the separation. Roentgenographic evidence of fracture through the base of the ulnar styloid, or of separation of a medial fragment of the radius (Fig. 2) is also confirmatory of loss of joint integrity. The importance of recognition of this complicating injury cannot be overemphasized.

TREATMENT

Prompt accurate restoration of normal anatomical relationships is very important. We believe that reduction should be carried out under the fluoroscope, with general anaesthesia. Unless there is a definite contra-indication to ether, we do not advise the use of novocain in these more complicated cases. Special attention must be paid to breaking up the impaction, restoration of the proper length and articular angle of the radius, and restoration of the dorsal position of the ulna.

At the same time, the ulna must be brought into close apposition to the radius to prevent widening of the wrist. The most stable position for fixation is that of palmar flexion with extreme pronation and ulnar deviation, the so-called Cotton-Loder position. If the ulna has been properly restored to its dorsal position, this manoeuver wedges the hamate partly beneath the distal ulna, and prevents forward luxation. This then gives stability to the ulnar side of the wrist; and further palmar flexion, pronation, and ulnar deviation put traction through the carpal ligaments on the radial fragments, lifting them into place and using the wedged ulna as a fulcrum. Continuance of ulnar deviation serves further to snug the radius up to the ulna and to permit reparative processes to reconstruct the ligamentary attachments. Maintenance of the position is greatly facilitated by immobilization of the elbow, which prevents any possibility of

supination. Acute palmar flexion alone, without pronation and ulnar deviation, will not suffice to maintain reduction in many instances, for slipping of fragments may occur. Fixation in the desired position is secured by a plaster-of-Paris cylinder or preferably by the so-called sugar-tong splint made of a single strip of plaster.

This extreme position of reduction should not be maintained for more than ten days, after which the wrist should be restored to a neutral position and safeguarded with simple molded splints for another ten days.

After-care and physiotherapy are carried out in this type of fracture essentially as they are in the less complicated type. Disability usually lasts for about two months.

LATE CASES

A considerable number of cases of Colles' fracture are treated without recognition of this complicating factor of loss of integrity of the radio-ulnar joint. These cases account for most of the poor end results seen after this fracture. Shortening of the radius and the backward tilt of its carpal articular surface are usually due to failure to break up the impaction completely. The broad wrist and loss of the dorsal prominence of the ulnar head are due to failure to restore the ulna to its proper position in the reduction. Limitation of motion occurs chiefly in pronation and supination, and this motion is likely to be painful and is sometimes accompanied with a jog or even an audible click. There is usually tenderness over the ulnar head or the ulnar collateral carpal ligaments, and the patient is likely to refer pain to these areas. In the extreme cases the ulnar head presents marked abnormal mobility, in some positions appearing as a dorsal prominence and again medially or anteriorly. If the ulnar head is grasped, it can be found to be freely movable in relation to the radius and to the hand.

In some instances simple osteotomy to restore the radius to its proper position is sufficient to relieve the patient of his disabling symptoms[1]. More often and more effectively, subperiosteal resection of the distal end of the ulna is employed as described by Darrach, and Cotton and Morrison.

SUMMARY

The function of the discus articularis is to stabilize the inferior radio-ulnar joint.

This ligament may be injured in Colles' fracture.

This complication requires a different technique of reduction and immobilization.

Failure to recognize the injury definitely jeopardizes a favorable prognosis.

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OSSIFICATION OF THE TENDO ACHILLIS

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Ossification of the tendo achillis is a definite, yet rare, clinical entity. Usually the ossification results from heterotopic bone formation arising within the body of the tendon; sometimes it develops from the periosteum of the os calcis. As far as the writer has been able to determine, only twenty-one cases have been reported in the literature. The various authors offer many possible explanations of this phenomenon. It is suggested that the ossification may be: (1) an embryonic rest or inborn anomaly; (2) a neoplastic growth; (3) a sesamoid bone such as is found in the tendons of birds; (4) osteogenesis from osteoblasts circulating in the blood stream; (5) growth of bone from a torn or injured periosteum; (6) chronic infection; (7) trophic disturbance due to tabes dorsalis; (8) bone formation by fibroblasts which have taken over a bone-forming function; (9) bone formation by osteoblasts which have metamorphosed from fibroblasts.

Sixteen of the twenty-one patients whose cases have been reported were males and five were females. In eighteen cases the new bone apparently developed free in the body of the tendon. In three it was thought to have been an outgrowth from the calcaneum. Seven patients gave a history of definite injury, such as a blow on the heel or a sprain of the tendon. Five gave a history of club-foot; four of these patients had had a tenotomy of the Achilles tendon and one a resection of the plantar fascia. Two cases were attributed to injury to the periosteum of the calcaneum at the point of the insertion of the tendon, due in one case to the wearing of high-heeled shoes and in the other to stiff counters on the shoes. In one case syphilis was blamed; in another, tabes dorsalis. In one case there had been an old osteomyelitis of the calcaneum; and in another, an abscess of the gastrocnemius. In three cases no apparent cause existed. In only one of the reported cases was there a rupture of the tendon.

When the ossification is due to outgrowths from the calcaneum, it is analogous to traumatic myositis ossificans and may be termed "tendonitis ossificans traumatica". A great deal of experimental work has been done and many clinical observations have been made in an effort to explain heterotopic bone formation, but there is no agreement as to the exact mechanism of this phenomenon. Leriche feels that it is a simple process and states that it originates with an injury or tear in the tendon. Hemorrhage follows, and later calcification of this necrotic area results. This calcification stimulates the fibroblasts to form bone. Huggins demonstrated that the epithelium of the urinary bladder stimulates certain fibroblasts to form bone. He does not believe that intermediate calcifica-

tion is necessary; he also differs with Leriche in that he feels that an osteoblast is a specific type of cell. Jones and Roberts state that the osteoblast is simply a fibroblast enlarged because it is active, and that bone will be formed at any point where there is excess calcium, provided that there is an adequate blood supply. It is obvious, then, that the exact mechanism of this ossification is not clear.

Treatment of this condition is not difficult. If no symptoms are present, no operative procedure is necessary. If pain is found, operative removal of the ossification is desirable. In cases of rupture of the tendon, suture of the tendon is necessary with or without removal of the ossified area.

CASE REPORT

N. M., white male, aged forty-two years, a railroad trainman, had been in the hospital on two occasions previous to the present accident. He had been hospitalized for two days in 1922 for treatment of an urethral stricture which was thought not to be gonorrhoeal. Routine roentgenograms of the kidneys were negative, but a deficiency of the neural arch of the first sacral segment was noted. Several months later the patient had been in the hospital again because of a fracture of the right os calcis. He had fallen from the top of a slowly moving boxcar and had landed on the tracks twelve feet below. There was little or no displacement of the fragments, and a cast was applied without anaesthesia. At that time there was no complaint of injury to the left foot or ankle. The patient had returned to work after four months entirely well.

On August 15, 1933, the patient was at his work, running along a stone-ballasted track to throw a switch, when he felt something snap in the left heel. He had not turned the ankle and was at a loss to explain the cause of his trouble. He did not fall and was able to continue on his way, but he could not rise on the toes of this foot. He was seen by the writer within a few hours, and inspection of the left ankle revealed moderate swelling and a definitely perceptible break in the continuity of the tendo achillis about two inches above its attachment to the calcaneum. Palpation revealed considerable tenderness in this area, and a forefinger placed across the back of the heel fitted deeply into the defect.

Roentgenographic examination of the left foot (Fig. 1) revealed an area of ossification in the region of the tendon, about three inches long and three-fourths of an inch in diameter, the lower end of the ossified area being three inches above the insertion of the tendon into the calcaneum. Roentgenograms of the tendo achillis of the right foot showed no ossification. Fourteen hours after the accident, an open operation was performed. There was a marked subacute inflammatory reaction in the tendon and the tendon sheath, the two being generally adherent but separable by blunt dissection. The tendon was separated for a distance of about one-half an inch at a point approximately two inches above the calcaneum. Palpation of the tendon above the point of separation and in the area of opacity, as demonstrated by the roentgenogram, revealed an indurated bony mass. It was impossible to penetrate into it with a suture needle. The break in the tendon had occurred about one-half an inch below the ossified section. For some distance on either side of the break the tendon was very necrotic and friable, and histological examination of a section removed showed necrotic tendon tissue with considerable hemorrhage and a slight acute inflammatory reaction. The defect was sutured with kangaroo tendon, and the wound was closed with catgut. A plaster cast was applied with the foot in the plantar-flexed position, and ten days later the patient left the hospital on crutches. The cast was removed after seven weeks, and the patient began to get about without crutches, but with a three-fourths-inch lift on the heel of the left shoe. He returned to his regular work after four months and has remained there, doing

the rather strenuous duties of a railroad trainman. He complained some of pain in the heel for about a year after the operation. At that time the repair seemed strong and the lift on the heel was discarded. Examination in November 1936 revealed slight tenderness and induration about the region of the tendon, but there was no evidence of weakness, or of impaired function, or of defect in the tendon.

FIG. 1

This case is undoubtedly one of heterotopic bone formation of the tendo achillis. The cause of that ossification is uncertain. Possibly the patient may have torn the fibers of the tendo achillis eleven years previously when he fractured the right os calcis, although there is no history of such an injury. The fact that he has a deficiency of the neural arch of the first sacral segment makes one consider that the ossification in the Achilles tendon may be an associated congenital phenomenon.

ABSTRACTS OF REPORTED CASES

Höring. The patient was a man, fifty-six years old, roentgenographic examination of whom showed evidence of two shadows in the left Achilles tendon. This was thought to have been caused by the patient's striking the heel on a hard object almost a year previously, as he had had pain in that heel almost constantly since that time. There was some bone formation in the right Achilles tendon, although there had been no injury there. The mass removed from the left Achilles tendon showed some cartilage and some spongy bone. Höring termed this condition "tendon-

itis ossificans traumatica" and regarded it as similar to myositis ossificans traumatica.

Painter and Clark. The authors reported two cases. The first was that of a man of thirty-eight years, who had caught the left foot between two bales of cotton four months previously. Two nodules developed in the tendon soon after. The tendon was incised and the two nodules were removed. Their second case was that of a man of fifty-one years, who had had stiffness in the cord of the right heel for five years. He regarded it as "rheumatism", although there was marked atrophy of the calf, resulting from an old inflammatory process which had destroyed the gastrocnemius muscle. Operative treatment was not warranted. These authors regarded the condition as similar to myositis ossificans.

Jacobsthal. The patient was a man, sixty years of age, who had bilateral congenital club-foot. Because of this condition the plantar fascia had been resected when he was one year old. He had been having pain in the heels during the past five years, this pain having come on gradually without known cause. Roentgenograms showed a bone formation in the left Achilles tendon, four by nine centimeters in dimension, and one in the right tendon, measuring one by five centimeters. Neither mass was attached to the calcaneum. The author attributed the ossification to the tenotomy.

Meyer. The patient was a man who had injured his foot four years previously. Apparently a traumatic pes equinus had developed for which a tenotomy of the Achilles tendon had been performed. Immediately before he was seen by Meyer, he had suffered a slight injury to the heel, which caused pain and swelling. Roentgenograms showed a shadow which was regarded as either ossification or calcification, probably the former. The area was several inches long and was not attached to the calcaneum. Meyer thought that a hematoma had developed in the tendon at the time of the tenotomy, which had become calcified and later ossified.

Sundt (cited by Mazzini, Reyes, and Monzo). This case is one of calcification or ossification in the tendo achillis of a boy, nine and one-half years old.

Steiger. The patient was a woman, thirty-three years old, whose illness had begun when she was twelve years old. A small indurated swelling developed on the heel. Roentgenograms demonstrated an ossified area which was not attached to the calcaneum It was removed by open operation.

Haglund. This patient was a man, sixty-seven years old, who was seen because of disability of the left foot. He recalled that as a youth he had cut the heel on a scythe, but he could remember no other injury. Four months previously, acute pain and swelling had developed in the heel, which he regarded as "rheumatism". Roentgenographic examination demonstrated a shadow in the tendon. There was no shadow in the tendon of the other foot, nor was any abnormal ossification found else-

where in the body. Since the patient was having little or no trouble with the heel, no operation was performed. Haglund stated that, since tendon tissue is phylogenetically the same as muscle tissue, ossification may develop there as easily as it can in muscles.

Pinard, Vernier, and Abricosof. Their patient had a large osteophyte in the left Achilles tendon. He also exhibited a partial positive Wassermann reaction, and the authors felt that the ossification in the Achilles tendon was associated with the syphilis.

Koehnlein. The patient was a man of fifty-five years, who, at some earlier time, had had osteomyelitis of the right calcaneum. Two areas of bone formation were present in the Achilles tendon,—one, three and four-tenths by one and four-tenths centimeters, beginning at the calcaneum; and another above this, two and two-tenths centimeters by six-tenths of a centimeter. This author discusses in some detail the possible causes of this condition, mentioning especially tumor, periosteal outgrowth, inborn anomaly, and aperiosteal metaplasia. He is inclined to believe that the last named is the proper explanation and states that it is not important whether the cells which form the bone are osteoblasts or fibroblasts, as they both come from the same embryonic tissue originally.

Patel. The patient was a sixteen-year-old girl who had been seen six months previously because of hard swellings on both of the heels. They had appeared some time before without known cause. They were sufficiently painful to interfere with walking. The tumefactions were adherent to the upper edge of the posterior surface of the calcaneum. The swellings on the right were the size of a nut and on the left they were somewhat smaller. Roentgenographic examination showed no shadows. These nodules were removed and were found to be bone. The author felt that they were not sufficiently ossified to show in the roentgenogram. He believed that the osteomata had developed because of traction or pressure at the insertion of the Achilles tendon, due to the wearing of extremely high-heeled shoes. He thought the periosteum had been torn or irritated.

Berard (reported in the discussion of the case of Patel). The patient was a woman of thirty-eight years who had had pain in the heel for some two years. Examination showed a column of bone, two centimeters in length, arising at the posterior apophysis of the calcaneum and extending into the Achilles tendon. The author regarded this to be an osteoma caused by irritation or tearing of the periosteum. He thought the hard counters on the shoes might have started the trouble.

Chevalier. The patient was a woman, seventy-eight years old, who had come to the hospital because of an abscess on the top of the left foot. Examination showed a painless indurated mass in the left tendo achillis, and roentgenograms revealed an ossified mass at this site, three or four centimeters long. Since this condition did not trouble the patient, no operation was considered. The author felt that this was some sort of trophic disturbance and that it was not due to periosteal injury.

Sainton and Péron. The patient was sixty years old and suffered

from tabes dorsalis. Routine examination showed the swelling in the heel, and roentgenograms disclosed an ossification in the tendo achillis, which was not attached to the calcaneum. The patient had no pain in the heel, and no operation was performed. These authors felt that the ossification was a trophic disturbance and was associated with the tabes dorsalis.

Mallinson. The patient was fifty-six years old and had been born with a bilateral talipes equinus. At eight years of age, a bilateral subcutaneous tenotomy had been performed. The patient was able to get about without a great deal of difficulty, but one day, while at work, he felt a sudden sensation in the left heel as though he had been struck a heavy blow. Roentgenographic examination revealed bilateral ossification of the tendo achillis, with fracture of the left. Open operation was performed, and the fragments were sutured with silver wire. Afterwards this patient got about with a three-fourths-inch lift on the left heel. The author mentioned the introduction of chronic infection at the time of the original operation as a possible cause of this condition. He also stated that it might have been due to excessive strain of the tendons or possibly to metabolic error or vitamin deficiency.

Volkmann. The patient was a woman, sixty-three years old. There had developed on the back of the left heel what she regarded as a blister. She did not know what the cause of this was, but it gave her considerable pain and made her limp. Roentgenographic examination showed a spur on the calcaneum and also two ossified areas in the Achilles tendon, the lower one apparently being attached to the calcaneum. There was also a small bony formation at the attachment of the right Achilles tendon. The osseous bodies were removed by open operation. The author stated that this condition is similar to the so-called myositis ossificans and that it may be spontaneous, traumatic, or similar to the bony tendons found in birds. He regarded this case as being traumatic and due to chronic irritation because of painful walking due to the heel spurs. He believed that the ossification followed the deposition of calcium in the injured tendon.

Scherb (cited by Volkmann). The patient was a man, forty-nine years old, who had fractured the left femur twenty-seven years previously. One year before hospital admission he had refractured the femur and had also fractured a metatarsal bone. Examination showed complete fixation of the subastragalar joint and a talipes equinus. The Achilles tendon was lengthened, and a small section of the bony tissue was removed. Microscopic examination showed spongy bone as well as areas of calcification and cartilage, the central part of the body being fibrous.

Densow (cited by Volkmann). A man, thirty-nine years old, had struck the back of the left heel on a hard object thirteen years previously. An indurated swelling had developed, but it had given the patient little trouble. He came into the hospital because of an axillary adenitis; routine examination revealed the swelling in the left heel and roentgenograms

showed the ossification. No operation or microscopic studies were possible. This author compared this bone formation to that in tendons of birds.

Jones and Roberts. The patient had had a tenotomy of the Achilles tendon twenty years previously. Roentgenographic examination showed an extensive calcification in the tendon, beginning a short distance above the calcaneum and extending high into the calf. There was also a calcification of the supraspinatus tendon. These authors believed that the ossification of the tendo achillis was one of true heterotopic bone formation and that it followed the tenotomy. He stated that a calcareous deposit would naturally develop in the fibrotic area of the tendon because of its decreased vascularity. Ossification would follow the calcification in the manner described by Leriche. They stated that this is a quite different process from the ossification due to an avulsion of the periosteum of the calcaneum, the latter condition being similar to myositis ossificans.

Mazzini, Reyes, and Monzo. These authors reported two cases. The first case was that of a man of seventy-six years, who had been losing strength in the lower extremities for the past three or four years. In addition, he had other symptoms suggestive of a deficient circulation in the lower extremities. He also had some muscular rigidity, so that he walked on the outer borders of the feet. Examination showed marked muscle atrophy and coldness of both lower extremities. The roentgenogram showed an ossified mass, nine centimeters long, in the right Achilles tendon and another, eleven centimeters long, in the left Achilles tendon. The latter tendon had a break in the continuity as though it were fractured. The masses were not attached to the calcaneum. The second case was that of a man, forty-three years of age, who, several years previously, had injured the left foot while getting out of a wagon. He had caught this foot in a cable which was charged with electricity and he had suffered a severe local injury. Examination showed some discoloration of the left leg, as well as some oedema and venous engorgement. Roentgenograms disclosed an ossified area, seven centimeters long, which seemed to have been fractured. In addition to reporting these two cases, these authors summarized fifteen previously reported cases and listed the various explanations which have been offered for this ossification.

NOTE: Since this article was written, another case of ossification of the Achilles tendon has been reported by Hufnagl.

SUMMARY

1. In some cases of ossification of the tendo achillis, the ossification arises from the calcaneum and is of periosteal origin. In other cases, the bone arises in the midst of the tendon. In spite of a great deal of experimental work and many clinical observations, the exact mechanism of this ossification is not clear.

2. The possibility that in some cases this condition is due to congenital defect should still be considered. Four of the cases reported

showed a congenital talipes. The case which the author has reported showed a congenital defect in the neural arch of the first sacral segment.

The writer wishes to thank Miss Maude E. Nesbit and her associates at the New York State Medical Library for their help in connection with the bibliography.

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INTRA-ARTICULAR DISPLACEMENT OF THE INTERNAL EPICONDYLE FOLLOWING DISLOCATION

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Although the subject has been described by others, the frequency with which the internal epicondylar epiphysis is displaced into the joint following dislocation of the elbow, especially in childhood, has not been fully recognized. Within the last ten months six such cases have been seen by the authors. The danger of this complication lies not only in the loss of motion of the elbow joint but also in the great possibility of permanent damage to the ulnar nerve. Two of our patients entered the hospital because of such paralysis.

The medial epicondyle is a rounded prominent projection of the distal humerus. Lying outside the joint capsule, it has a separate epiphysis which appears at the fifth year and fuses at the eighteenth. It serves as the common origin of the flexor group of forearm muscles and as the attachment of the anterior and posterior portions of the ulnar collateral ligament of the capsule. The ulnar nerve lies in a shallow groove on the pos-

FIG. 1-A FIG. 1-B

Posterolateral dislocation of the elbow. Note the epiphysis of the internal epicondyle lying directly over the olecranon fossa in the lateral view and between the shaft and ulna in the anteroposterior view.

FIG. 2-A

Right elbow (normal). Note the relationship of the epiphysis to the shaft and the width of the normal joint space.

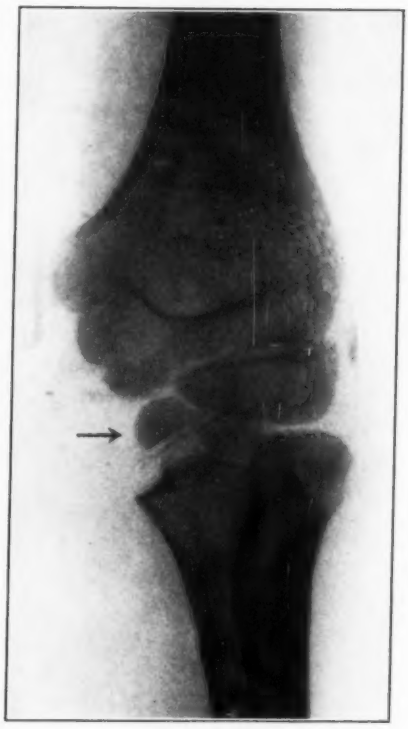

FIG. 2-B

Left elbow. Note the epiphysis of the internal epicondyle lying in the elbow joint, and the increase in width of the joint space.

terior surface of the epicondyle and is attached to it by fascial bands. Distal to the epicondyle the nerve enters the flexor muscles a short distance below their insertion to the epicondyle.

A fall upon the hand, with the forearm abducted and the elbow slightly flexed, is apt to cause posterior or posterolateral dislocation of the elbow. Such a fall also exerts a pull upon the common flexor tendon and the ulnar collateral ligament, both of which are attached to the internal epicondyle. As a result, an avulsion of the epicondyle at the epiphysis occurs. The fragment is then pulled downward and forward by the flexors. The entire fragment, free of the humerus, is then carried backward and laterally with the displaced ulna, so that it lies posterior to the trochlea and anterior to the semilunar notch of the ulna.

In the reduction the epicondyle is thus in a position either to drop into the notch or to be forced in as the humerus slides backward into the notch. The epicondyle, locked within the joint, carries with it the insertions of the flexor muscles and the ulnar nerve. The nerve is thus apt to be crushed between the bone surfaces, or, more commonly, severely stretched and constricted either by the fascial bands which bind it to the epicondyle or at

FIG. 2-C

Lateral view of right elbow (normal). Note the width of the joint space. The epicondyle can be seen through the joint space, but it is not within the joint.

FIG. 2-D

Left elbow. Note the increase in width of the joint space and the presence of the epiphysis within the joint.

the point where it enters the flexor muscles. When such a displacement occurs, immediate reduction is imperative if severe or permanent nerve damage is to be avoided. Early postreduction roentgenograms, interpreted with special attention to the position of the internal epicondyle, are the best safeguards against later nerve changes and a poor functional end result. In Figure 2-B the internal epicondyle was interpreted by two roentgenologists as an anomalous epiphysis of the olecranon. In case of doubt, it is well to x-ray both elbows in the anteroposterior and in the lateral views. The position of the epicondyle and the presence of anomalous epiphyses can then be readily determined.

DIAGNOSIS

Reliance should be placed more upon a roentgenographic study than upon symptomatology. If the patient is seen early, palpation should reveal the absence of the medial epicondyle and even the roughened bed of the fragment. The elbow is carried in a partially flexed position. There is moderate loss of flexion, as well as marked loss of extension. There is a slight increase of the carrying angle. Most of our patients were seen

FIG. 3-A

FIG. 3-B

The epiphysis of the internal epicondyle lies within the joint. Note the increase in width of the joint space in both views.

several hours after the dislocation of the elbow had been reduced. In these cases the joints were so swollen and painful that the physical findings were of little aid in making the diagnosis.

In the roentgenograms the medial widening of the joint space with an absence of a normally situated medial epicondyle is diagnostic. (See Figures 1-A, 1-B, 2-A, 2-B, 2-C, 2-D, 3-A, 3-B, and 4.) In each of these cases the fragment was plainly seen interposed between the trochlea and the olecranon. According to other writers, this finding is not always present, especially in patients under seven years of age, at which time the medial epicondyle is mostly cartilage.

Immediate ulnar-nerve signs are usually not present unless the nerve has been subjected to excessive trauma during reduction or at the time of injury. Usually, if present, they will not be noticed by the patient unless attention is directed toward them by the examiner. After the acute reaction and pain at the elbow have subsided, the patient becomes aware of the areas of anaesthesia and muscle weakness. In the majority of cases, nerve symptoms—both sensory and motor—increase in intensity, due to the constriction produced by the fascial attachments extending from the nerve to the imprisoned epiphysis. Cotton reported three cases with definite neural signs, in one of which the nerve had been drawn into the joint and was lying alongside the avulsed fragment. Four of the five patients whose cases were studied by Wilson had ulnar-nerve paralysis of varying degrees. In our group three of the six patients had symptoms of ulnar-nerve pressure.

TREATMENT

If the dislocation has been reduced and the fragment lies within the joint, the only treatment is immediate surgical reduction. It is not possible to manipulate the epicondyle out of the joint unless the elbow is redislocated. Although successful in this manoeuver, one may by such forced manipulation seriously injure the exposed nerve. If, however, the patient is seen before the dislocation has been reduced, it may be possible to keep the medial side of the joint open during manipulation and thus permit the fragment to escape. This did occur in one case in which roentgenograms before reduction showed the epiphysis pulled down and laterally to a position beneath the trochlea. Accidental reduction occurred while the patient, holding his injured arm at the wrist, sat down on a chair. The fragment was thrown clear and later roentgenograms showed it near its original location.

FIG. 4

The epiphysis lies within the joint.

Surgical approach to the fragment is best made through a three-inch posteromedial curved incision extending from the epicondylar bed down over the medial aspect of the joint. The nerve is found posterior to the fracture surface of the humerus and should be followed distally to the point where it enters the joint. The flexor muscles are then identified and can readily be seen to enter the joint. The forearm is then abducted at the elbow to widen the joint space medially, while a curved periosteal elevator is placed under the muscles where they enter the joint. By traction on the muscles by means of the elevator, the fragment is easily reduced. A full range of motion should follow.

The fragment may be excised or reattached. In either case the common flexor tendon is sutured either to the periosteum or to the humerus through a drill hole. Fixation may be performed by means of a nail. As the epiphysis in question contributes only to the growth of the epicondyle, growth disturbance because of excision or internal fixation is of no clinical importance.

In all cases it is well to transpose the ulnar nerve anteriorly. This is done to prevent further damage to the nerve either by rubbing over the roughened epicondylar bed of the humerus or by becoming caught in the fibrous tissue during healing of the fracture.

Following operation, the arm is immobilized in flexion with pronation of the forearm either in a sling or in a posterior plaster shell. Motion may be started in from three to four weeks.

SUMMARY

1. Intra-articular displacement of the internal epicondylar epiphysis may complicate elbow dislocations in children with injury to the ulnar nerve.

2. Postreduction roentgenograms of all elbow dislocations should be taken to rule out this complication.

3. Immediate surgical reduction is the best course, although closed reduction is possible if the medial joint space is widened during manipulation.

4. Anterior transplantation of the ulnar nerve is advisable whether the epicondyle is excised or reattached.

5. An excellent end result may be expected if the condition is treated promptly and correctly.

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THE USE OF AMNIOTIC-FLUID CONCENTRATE IN ORTHOPAEDIC CONDITIONS *

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In 1927 Johnson reported on the use of human and bovine amniotic fluid as an agent which would stimulate the defense mechanism of the peritoneum. The human amniotic fluid obtained at cesarean section was at first employed, but later a concentrate prepared from bovine amniotic fluid was substituted. Considerable literature exists regarding the use of this concentrate within the abdomen. It shows that the introduction of the concentrate within the peritoneal space excites the early production of a defense exudate; that it produces a reaction simulating the normal process of repair; and that it inhibits the development of a dangerous peritonitis.[9] There is also some evidence to show that its use prevents, or at least minimizes, postoperative adhesions.[7, 12, 13] Personal experience in the use of this concentrate within the abdomen is in agreement with these conclusions.

Three years ago the thought occurred to the author that, if the amniotic concentrate was effective in hastening the process of repair within the peritoneum, it ought to be of value in other serous cavities, including those of the body joints. Therefore, a study of the use of amniotic-fluid concentrate within the joints under varying conditions has been made. This report is the result of that study.

The composition of amniotic fluid[17] is that of a hypotonic liquid, with a specific gravity never above 1.010. It contains coagulable albumin, cholesterol, histidine, lysin, allantoin, certain inorganic compounds, and varying amounts of mucin. The work of Cantarow, Stuckert, and Davis shows that the fluid is not urine or a serum dialysate, but a true product of the amniotic cells.

There was used in the work upon which this report is based an amniotic concentrate now on the market. This product is obtained by concentrating, fractionating, and purifying the amniotic fluid of cows which are from two to four months pregnant. At this period of bovine gestation, it is unlikely that contamination of the fluid would occur, and, unlike the human foetus, there is no possibility of urine contamination from the calf.[6]

It is of importance to know that Johnson demonstrated that this fluid is harmless when injected intraperitoneally.[5] In this work no ill effects have followed its use in the joints. The concentrate employed is

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superior to the whole amniotic fluid because in its preparation the protein content is reduced, and it is rendered sterile and stable.

CLINICAL APPLICATION

The total number of cases in which the concentrate was used within joint cavities was sixty-eight. These cases may be classified as follows:

Types of Cases	*No. of Cases*
Arthrotomies (clean)	26
Closed manipulation of joints	12
Fractures involving joints	8
Fractures adjacent to joints	7
Joint effusion (etiology unknown)	4
Joint effusion (gonorrhoeal)	1
Atrophic arthritis	8
Sympathetic joint effusion	1
Subacute joint infection	1

There were twelve cases in which amniotic concentrate was used on tissues outside of joints.

The joints in which amniotic concentrate was used were as follows:

Joint	*No. of Cases*
Knee	46
Shoulder	8
Elbow	6
Hip	5
Ankle	2
Wrist	1

ARTHROTOMIES (CLEAN)

For some time past the procedure of introducing amniotic concentrate into all joints after intra-articular surgery has been employed.

Technique: After the necessary surgery has been completed, a moderate-caliber needle is introduced well into the joint space, and the joint is completely closed around the needle; this includes skin closure. The concentrate is then introduced in sufficient amount to distend the joint cavity with the fluid. This requires varying amounts of the liquid. In the knee joint as much as 100 cubic centimeters has been injected. The amount used varies with the individual joint. Enough fluid is introduced to cause separation, even if minimal, of the articulating surfaces.

Warren has demonstrated experimentally that the absorption of the concentrate within the peritoneal cavity proceeds as follows: The fluid introduced drops in content one-half during the first four hours; there is 15 per cent. left at the end of twenty-four hours; and it has completely disappeared within forty-eight hours. It is believed that the rate of absorption within joints is somewhat slower. The concentrate is absorbed rapidly at first, but at least 25 per cent. remains at the end of twenty-four hours, and it may be as long as sixty hours before complete absorption has taken place.

Warren has also made the interesting observation that the period of

oozing of a traumatized peritoneum is reduced by half when the amniotic fluid is employed. A similar action takes place on injection of the concentrate into a joint cavity, and this is a factor of prime importance in intra-articular surgery.

Johnson, in experimental work with the concentrate in the peritoneal cavity,[8] showed that a maximum white-cell response occurred within twelve hours. He found an impressive subserous oedema with a minimal hemorrhagic response, as shown by the merely pinkish exudate. This exudate was rich in fibrin, and, if withdrawn after four hours, it jelled immediately. Later on, as the total white-cell count receded, a variable percentage of histiocytes was found.

In two cases in which joints were aspirated after the introduction of the concentrate, it was found that in one case, after four hours, the aspirated fluid jelled almost immediately, thus demonstrating its high fibrin content. The total cell count was 22,000 with 95 per cent. neutrophiles. In the second case, in which the fluid was aspirated at the end of twenty-six hours, the total count was 12,400 with 45 per cent. histiocytes. It would, therefore, seem plausible, as Johnson has pointed out, that the concentrate speeds up considerably the normal process of defense repair. Collins has shown that normal synovial fluid contains a mucin protein, and that the function of the mucin is to increase viscosity.[2] Jones has demonstrated that the function of any joint is dependent on the fluid pressure film of the synovial fluid, and that one factor in the proper maintenance of such a pressure film is the viscosity of the lubricant. Since amniotic concentrate contains mucin, it is logical that it would act as a joint lubricant.

In attempting to explain the *modus operandi* of amniotic concentrate after surgery within joints, it would be fair to state that it (1) reduces oozing time to a minimum, (2) excites a brisk defense-repair effort, (3) increases viscosity and acts as a lubricant, and (4) operates mechanically to separate traumatized joint surfaces.

Clinically it was observed in these twenty-six cases that postoperative pain was reduced to a minimum. As compared with cases in which the concentrate was not used, this difference was striking. No postoperative infection occurred in any case, but the significance of this in clean-joint surgery is slight. No postoperative adhesions occurred in any case. In all twenty-six cases the final functional result could be fairly rated as "good" to "excellent". It was found that function was more easily and rapidly restored when the concentrate was employed. In four cases it was deemed necessary to refill the joint. In nineteen cases the temperature postoperatively did not reach 100 degrees; in five cases it reached 100.2; and in two cases it went as high as 101. The systemic white count in twenty cases showed a postoperative leukocytosis of between 10,000 and 15,000. This, however, in view of the operative trauma, is of little significance. In no case was there observed a pathological effusion after surgery.

The absence of complications following twenty-six arthrotomies after using amniotic-fluid concentrate, as compared with those reported by Swett in 100 arthrotomies without its use, may or may not be significant. (See Table I.)

TABLE I

COMPARISON OF TWENTY-SIX ARTHROTOMIES AFTER USE OF AMNIOTIC-FLUID CONCENTRATE (SHIMBERG) WITH 100 ARTHROTOMIES WITHOUT ITS USE (SWETT)

	Without Amniotic-Fluid Concentrate	Following Amniotic-Fluid Concentrate
Postoperative Complications:		
Death	0 cases	0 cases
Infection	0 cases	0 cases
Excessive effusion	7 cases	0 cases
Adhesions and delayed return of motion	7 cases	0 cases
Manipulation to restore motion	4 cases	0 cases
Recovery Period:		
Duration of bed treatment (average)	9 days	5 days
Duration of use of crutches (average)	16 days	11 days
Recovery of functional use (average)	9.5 weeks	4 weeks
End Results:		
Full recovery	95 cases	25 cases
Slight remaining disability	5 cases	1 case

CLOSED MANIPULATION OF JOINTS

In these twelve cases, for one reason or another, it was deemed advisable to break down joint adhesions by manipulation under anaesthesia. Previous experience with such forcible manipulation had been unsatisfactory in that severe postoperative pain had occurred, and usually there had been a return of adhesions and disability. In these cases, after manipulative procedure, the joint in question was filled under the strictest asepsis with the concentrate. As much fluid as possible, without causing undue capsule stretching, was introduced. In joints other than the knee, technical difficulties were encountered, for most joints are difficult to enter with a needle unless an effusion is present. In the hip joint an anterolateral approach was used, the needle following the femoral head into the joint space. The shoulder joint was entered in a similar manner. A posterior approach to the elbow and wrist joints proved satisfactory. The ankle joint was entered lateral to the internal malleolus.

CASE 36. The patient, a male, aged thirty-eight, gave a history of gradual stiffening of the right shoulder with no known trauma. Roentgenographic examination was negative. Physical examination disclosed inability to abduct the shoulder beyond 45 degrees; the scapula moved simultaneously with the arm. Circumrotation was markedly limited and painful. There was no evidence of gonococcal infection. There was severe pyorrhoea. The sedimentation rate was 12.

The pyorrhoea was given adequate treatment, and, under anaesthesia (evipan), the shoulder was manipulated and dense adhesions were broken up. Twenty cubic centi-

meters of concentrate was introduced into the shoulder joint, and twenty-five cubic centimeters placed in the peri-articular tissues. The arm was superabducted and elevated when the patient returned to bed, and kept in that position for twenty-four hours. There was no complaint of excessive pain. After a period of twenty-four hours, all restraint was removed, and the patient was encouraged to move the arm as much as possible. No physiotherapy was prescribed. At first the shoulder could be moved in all planes with ease. Then there occurred a period of some stiffening, but within ten days the patient had a 90-per-cent. range of motion with but slight pain.

The patient was seen six months after discharge and stated that he had returned to his job as an automobile salesman, and that he had no trouble whatsoever with his arm. Examination did not reveal any abnormality of the shoulder.

In these cases it has not been found necessary to do a remanipulation, although in four there was administered a second injection of the concentrate after the operation. In only one case was there failure to achieve a moderately good or excellent result. The author fully agrees with the generally held opinion that in so-called idiopathic stiffening of a joint, such as the shoulder, the majority of the adhesions are extra-articular. This is the reason for the procedure of infiltrating the peri-articular structures. No untoward result from introducing the concentrate into tissues outside the joint has been observed.

FRACTURES INVOLVING JOINTS

In this type of fracture there is considerable joint trauma with bloody effusion, and the end result, in previous experience, has been unsatisfactory in the majority of cases.

In the eight cases reported the concentrate was employed with uniformly good results.

CASE 67. A male, aged forty-two, fell from a cherry tree, sustaining a severe injury of the right knee. He was seen within a few minutes after the fall. Roentgenographic examination showed that he had a spread-eagle fracture of the tibial head with multiple fissures extending into the joint, as well as a lateral dislocation of the tibia on the femur. A considerable joint effusion was present.

Under anaesthesia, the dislocation was reduced, although there was a tendency to redislocate. Due to the spreading of the tibial head, a Carrel screw was inserted, and the fragments were brought firmly together. The joint was aspirated, and fifty cubic centimeters of very bloody fluid was removed. This was replaced by seventy-five cubic centimeters of the concentrate, and a cast was applied. There was little postoperative pain. No narcotic was required.

At the end of five weeks, the cast and the Carrel screw were removed. At this time there was 25 per cent. active motion of the knee joint. Physiotherapy in the form of diathermy, massage, and active movement was instituted. The patient resumed full work without any support at the end of eight weeks and two days, with 85 per cent. of full function. In three months the function had returned to normal.

In this case, in spite of proved severe joint trauma, there was complete healing and return of normal function within an unusually short time. Similar results have been obtained in seven other cases of varying degrees of severity, in which the knee was involved in five cases, the shoulder in one case, and the ankle in two instances. It is felt that these results lend support to the theory that the concentrate excites an early defense-

repair effort with resolution without adhesions, and also that it quickly seals oozing traumatized joint tissues. Jones found that the pressure film of synovial fluid could withstand a load which would crush bone. In intra-articular fractures, it is reasonable to assume that even that resistant pressure film may be broken. It is also logical to believe that the amniotic concentrate restores the pressure film, so that the lubricant effect so necessary to normal function can once more operate.

In the case cited, there existed circumstances which made continuous hospitalization impossible. Consequently, but one filling of the concentrate was made. In four other cases the filling was repeated once in three cases and twice in the remaining case. A refill within sixty hours of the first injection of the concentrate is deemed generally advisable. The case in which three fillings were made was a severe crushing of the patella with injury to the femoral patellar facet. It was a compound fracture in which open operation was performed. In spite of the devitalized condition of the tissues, after a débridement and concentrate injection, first-intention healing and an 80-per-cent. normal end result were obtained.

In this type of fairly common injury, where good end results are so difficult to obtain, and where prolonged hospitalization and treatment are so often necessary, it is believed that the use of the amniotic concentrate is of distinct value.

FRACTURES ADJACENT TO JOINTS

In each of these seven cases there was a fracture adjacent to a joint, and, while there was no evidence of bony intra-articular injury, yet it was believed that some trauma to the joint tissues had occurred. In these cases, after reduction, a cast was applied and a window was cut over the nearby joint, through which from one to three fillings of the joint with the concentrate were made.

The functional results in these cases were excellent, and it was found that immediately after removal of the cast there was more than usual joint function. This procedure was prompted by the thought that amniotic concentrate might be of value in the treatment of closed fractures where there was reason to suspect some joint trauma.

JOINT EFFUSION (ETIOLOGY UNKNOWN)

There are certain types of joint effusions, especially in the knee, in which there is considerable doubt about the etiology. The four cases included under this head were ones in which a joint effusion had appeared and persisted, and in which there was no known etiological factor. In all cases, the knee was involved, and, in two instances, there had been several aspirations with reappearance of the fluid. After aspiration of the existing joint fluid, the joint cavity was distended with the concentrate in each case.

CASE 4. A male negro, aged forty-six, gave a history of fairly sudden swelling of the right knee with accompanying pain. The Wassermann test was negative, but

gonococcal infection existed. The knee had been aspirated twice before admission, but no information as to the type or amount of fluid removed was available.

The knee was aspirated soon after admission, and seventy cubic centimeters of a clear, thin, non-coagulable fluid was obtained. Its specific gravity was 1.015, and the fluid contained 1500 cells per cubic centimeter, 15 per cent. of which were neutrophiles. The joint was filled with seventy-five cubic centimeters of concentrate. After seventy-two hours there was no fluid remaining in the joint, and no return of the effusion occurred.

In the other three cases also, one filling of the concentrate was sufficient to prevent the reappearance of an effusion.

Collins states that, when the same joint is aspirated twice within a few days, there is a change in the viscosity of the fluid and the second "diluted", less viscous fluid is more amenable to natural absorption than the original effusion.[3] Whether the concentrate exerts some biological action in these cases, or whether there is a purely physical action concerned, involving surface tension and viscosity, is a matter of speculation.

JOINT EFFUSION (GONORRHOEAL)

CASE 42. The patient was a male, aged forty-six, who for years had had trouble with the right knee, and his history showed a gonococcal background. A gonorrhoeal arthritis seemed probable, even though the bacteriological study was negative. The knee, when first seen, was swollen, painful, and slightly hot to the touch. There was no temperature rise or increased systemic white count. There was a moderate amount of fluid in the joint, and the synovial membrane was definitely thickened. The roentgenographic findings were as follows: "There are punched-out areas along the outer margin of the knee joint and a destruction of cartilage as shown by the almost complete obliteration of the inner portion of the joint space."

Aspiration of the knee was performed and ninety cubic centimeters of thick green fluid was obtained. This did not coagulate. Examination of the fluid showed a considerable number of pus cells, but no organisms. A culture was sterile. Ninety cubic centimeters of concentrate was placed in the joint. Twelve days later there was a moderate effusion in the joint. This was aspirated and fifty cubic centimeters of clear, quickly coagulable fluid was obtained. This fluid showed but few pus cells, with a total white count of 14,500 and 67 per cent. neutrophiles.

There was a definite change in the character of the fluid following the use of the concentrate. After the second injection, there was no marked accumulation of fluid within the joint. The patient stated that his knee felt better than it had for some time past, but there still remained considerable joint pathology.

ATROPHIC ARTHRITIS

In atrophic arthritis the joint manifestations are but local outcroppings of a profound systemic disease. It is logical to assume that, even though the systemic aspects of the disease may be brought well under control, the pathology initiated in the joints, being of an inflammatory character, will go on to some degree of joint damage.

In six cases of subacute atrophic arthritis, in which there was either joint effusion or marked pathology of the synovial membrane, the concentrate was used in an effort to limit the damage. Timbrell Fisher has reported excellent results in such cases with arthrotomy and lavage with Dakin solution. In this study the knee joint was entered with a needle, and such fluid as was present was withdrawn and replaced with a larger

volume of the concentrate. This procedure was repeated from two to seven times. In an as yet unpublished paper on "Arthritis", a detailed report of these cases will be given. It suffices here to say that the results in the cases where the concentrate was used were satisfactory. The symptoms cleared up, and during the period of hospitalization the improvement was maintained.

In this connection, consideration must be given to the work of Keefer, Holmes, and Myers on the inhibition of tryptic digestion of cartilage by synovial fluid from patients with various forms of arthritis. They state that the antitryptic substances in the synovial fluid stop cartilage destruction. It is possible that the concentrate contains such elements.

The concentrate was used in two cases where the arthritic process had burned itself out and had left crippled, dry joints. After the correction of a flexion deformity, from one to five injections of the concentrate were made. It is believed that by this procedure fairly good joint function was established. This is an extensive field for further study.

Again it seems justifiable to assume that the defense-repair mechanism excited by the amniotic fluid had, as its end result, a resolution of joint pathology without fibrous adhesions.

SYMPATHETIC JOINT EFFUSION

It is well known that pathology in the vicinity of a joint will at times incite a sympathetic joint effusion, as illustrated by the following case.

CASE 39. The patient, a male, aged forty-four, gave a history of attacks of pain in the lower right thigh. During the last attack his knee had become swollen and painful. Roentgenographic examination showed a small, well-circumscribed Brodie's abscess in the lower end of the right femur close to the joint. The joint was hot, tender, and painful. A moderate effusion existed.

Aspiration was performed and forty-five cubic centimeters of clear, non-coagulable fluid was removed, which showed a total white count of 1800 and 21 per cent. neutrophiles. The fluid was bacteriologically sterile. These findings agree with those of Collins in similar effusions.[2] Sixty cubic centimeters of concentrate was introduced into the joint, and the patient stated that the knee became comfortable almost at once. In sixty hours the joint fluid was negligible, and there was no discomfort in the thigh. Roentgenographic findings did not change. The final result in this case is not known.

SUBACUTE JOINT INFECTION

There is reason to believe that amniotic concentrate exerts some bactericidal effect. The only literature on the subject [15] is unavailable. However, the following case is of some interest in this connection.

CASE 10. A male, aged forty-seven, developed a swollen and painful left knee without known cause. The temperature varied from 99.8 to 100.8.

The knee was aspirated and sixty-five cubic centimeters of cloudy fluid was withdrawn. This fluid contained many pus cells, and culture showed numerous colonies of staphylococcus aureus. Seventy cubic centimeters of amniotic concentrate was injected. Two days later there was a moderate effusion, and at that time forty cubic centimeters of fairly clear fluid was withdrawn. It contained fewer pus cells with the organisms less numerous. The fluid was replaced with fifty cubic centimeters of the

concentrate. The temperature dropped to normal after three days. There was no further effusion and the patient recovered.

No conclusions may be drawn from this one case, but it is thought-provoking.

THE USE OF AMNIOTIC CONCENTRATE ON OTHER THAN JOINT TISSUES

In four cases of slow-healing fractures, the concentrate was injected into the fracture site. Without a large controlled series it is impossible to evaluate the results obtained, but the clinical and roentgenographic evidence tended to show that the fluid was a stimulant of bone repair. This impression is in agreement with the experimental work of Morrison, Johnson, and Hazard. This procedure is definitely worthy of further clinical trial.

In eight other cases the amniotic fluid was used in soft tissues for various reasons. It was injected under the lumbar fascia for the forcible breaking up of adhesions. This procedure was suggested by Dr. Charles Murray Gratz of New York. As yet no decision has been reached as to its value for this purpose. It is again emphasized, however, that the use of the concentrate within soft tissues has never caused the slightest unfavorable reaction. It was used in a case of free skin graft with good results, also in two cases of moderate burns in which it appeared to have a mild anaesthetic effect. Its use in soft tissues, it is believed, might be considerably extended.

DISCUSSION

From the evidence submitted, amniotic-fluid concentrate appears to influence favorably the mechanism of defense repair. Its composition gives but meager information upon which to formulate a theory which will satisfactorily account for its beneficent action. It is true that it contains allantoin in small amounts, and there is evidence to show that allantoin is of value in promoting repair. It is to be considered that amniotic fluid is a true body fluid, and one of its functions is to prevent adhesions between the foetus and the amniotic sac.[19] There is also reason to believe that its action is not merely mechanical, but also biological.[8] Its use within joint cavities accomplishes several purposes. First, it distends the cavity with an innocuous fluid, and this mechanical distention separates to some extent the injured surfaces. This, after all, is probably nature's reason for creating an effusion in response to trauma or irritation. Secondly, it excites an immediate defense reaction in the intra-articular tissues with the formation of much fibrin, and at the same time reduces oozing time to a minimum. Further, as the defense reaction wanes, a repair process is stimulated. Apparently the normal body process of defense and repair is speeded up with a resultant early resolution, thereby limiting fibrous adhesions. Thirdly, the fluid influences intra-articular viscosity, and the lubricant factor in joint function is favorably affected. The results obtained by arthrotomy after injection of this fluid in this study compare favorably with those of others as regards postoperative complications,

time of functional restoration, and final end results. In fractures of the intra-articular type, there is no doubt that the fluid has definite value. In atrophic arthritis it seems indicated where there is effusion or marked synovial-membrane involvement.

It is realized that the number of cases reported is comparatively small, and that no definite conclusions can be drawn with any great degree of certainty. However, the observations made indicate that the use of amniotic-fluid concentrate has some value in orthopaedic disabilities.

SUMMARY

1. In sixty-eight cases in which amniotic-fluid concentrate has been employed in the treatment of various pathological conditions of joints, the use of the fluid concentrate has not been attended by a single unfavorable reaction.

2. Its action is probably both biological and mechanical.

3. It speeds up a defense-repair mechanism within the joints.

4. The results obtained have been impressive in intra-articular fractures, and encouraging in selected cases of atrophic arthritis, as well as in persistent joint effusions.

5. It successfully prevents the formation of new adhesions after closed manipulation of joints.

6. It is a valuable prophylactic after arthrotomy of any type.

7. Its use both in soft tissues and in other serous cavities is suggested.

The advice and splendid cooperation of Dr. C. B. Francisco during the research is much appreciated.

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FRACTURES OF THE METACARPALS

A New Method of Reduction and Immobilization

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Fractures of the metacarpals, involving the four inner fingers, have always been a disturbing and vexing problem. Irrespective of the fracture site, the deformity is always the same,—namely, *dorsal angulation*. Since these bones are so comparatively superficial, the cosmetic result is rather unpleasant. There is a "bump" on the dorsum of the hand and, what is even more important, there is a disturbance in the alignment of the knuckles, both in the frontal and in the sagittal planes. The head of each metacarpal is quite prominent in the palm of the hand, due to the angulation of the distal fragment. Particularly is this true of fractures just proximal to the head. The small distal fragment dips sharply downward into the palm and, because of its shortness and its close

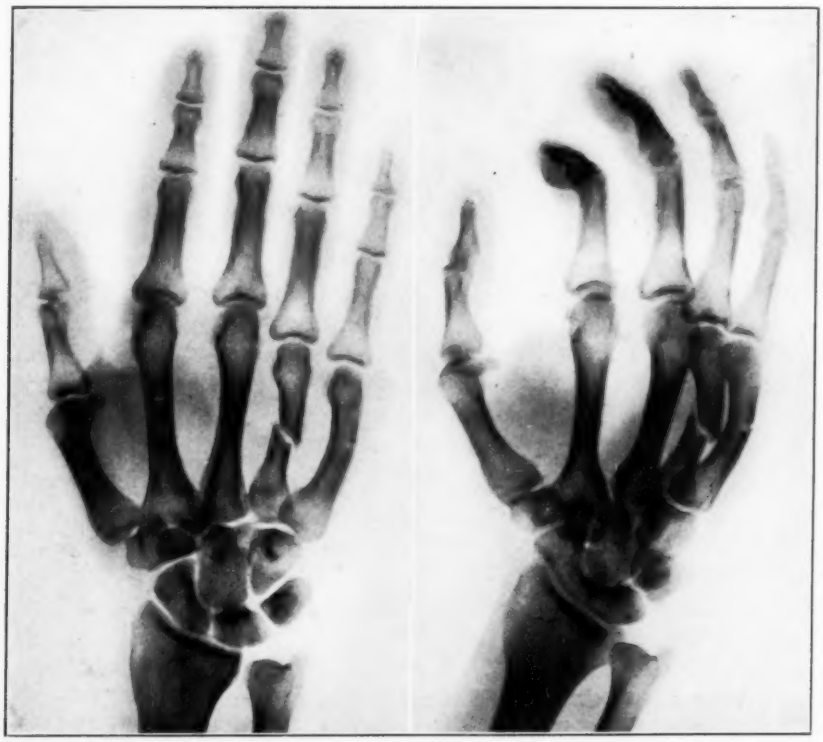

Fig. 1-A

Case 1. Fractures of fourth and fifth metacarpals; ulnar displacement of distal fragment of fourth metacarpal; oblique fracture of fourth metacarpal.

Fig. 1-B

Case 1. Overriding and dorsal angulation of the distal fragment of the fourth metacarpal and some dorsal angulation of the fifth metacarpal.

proximity to the metacarpophalangeal joint, control of the fragment becomes very difficult. (See Figures 3, 5, and 7-A.)

In an individual who, because of his vocation, must firmly grip some tool, such as a hammer, a saw, etc., the displacement causes undue pressure on the head of the metacarpal, with a resultant inability to work efficiently. In the case of a prize fighter, this malalignment prevents him from delivering a blow with full force.

Up to the present time no solution of this problem has been found. The variety of treatments offered is ample proof of this fact.

When any fracture is reduced, the distal fragment is brought into alignment with the proximal one and maintained in that position by some means of immobilization.

In dealing with metacarpal fractures, excluding those in the proximal half of the shaft, there is no direct purchase on the small distal fragment, making it necessary for the surgeon to attempt reduction through the agency of the finger. However, between the proximal phalanx and the fracture site is the metacarpophalangeal joint, which has motion in all directions. This motion must be nullified before direct control of the fragment can be obtained. Extension of the finger does not produce this effect and, to make things worse, it increases the dorsal angulation. As is well known, extension makes the interosseous muscles taut and, since these muscles maintain the angulation, this pull on them will cause greater buckling of the fragments.

FIG. 2-A

Case 1. After reduction and immobilization. Ulnar displacement corrected.

FIG. 2-B

Case 1. Complete correction of the dorsal angulation.

FIG. 3

Case 3. Fracture of the fifth metacarpal just distal to the head. Note the marked dorsal angulation.

FIG. 4

Case 3. Perfect alignment after reduction.

When the finger is flexed at the metacarpophalangeal joint to an angle of 90 degrees, the head of the metacarpal is so firmly fixed to the base of the proximal phalanx by the collateral ligaments that any motion of that phalanx causes the head of the metacarpal to move along with it. In this position, by pushing upward or dorsally on the flexed finger, extension of the distal fragment is effected, correcting the dorsal angulation, even though the fragments are not handled directly.

In the index and middle fingers this is easily accomplished, but in the ring and little fingers a slight difficulty is encountered,—a little more so in the fifth than in the fourth finger. It is necessary to push these fingers farther dorsally than the others. Upon investigation the reason for this is found to be elementary. In the carpometacarpal joint of the little finger there is extension of about 25 degrees, whereas in the ring finger this motion amounts to only 15 degrees. In the corresponding joints of the index and middle fingers there is no dorsal motion whatsoever. When upward or dorsal pressure is brought to bear on the head of the metacarpal through the flexed finger, the angulation cannot be overcome until the proximal fragment becomes fixed. Since there is no motion in the carpometacarpal joints of the index and middle fingers, the proximal fragment is fixed physiologically, and all the dorsal excursion

FIG. 5

Case 7. Oblique comminuted fracture of the neck of the fifth metacarpal. Dorsal angulation and palmar overriding.

FIG. 6-A

Case 7. After reduction. No dorsal angulation.

FIG. 6-B

Case 7. Perfect alignment of the fragments.

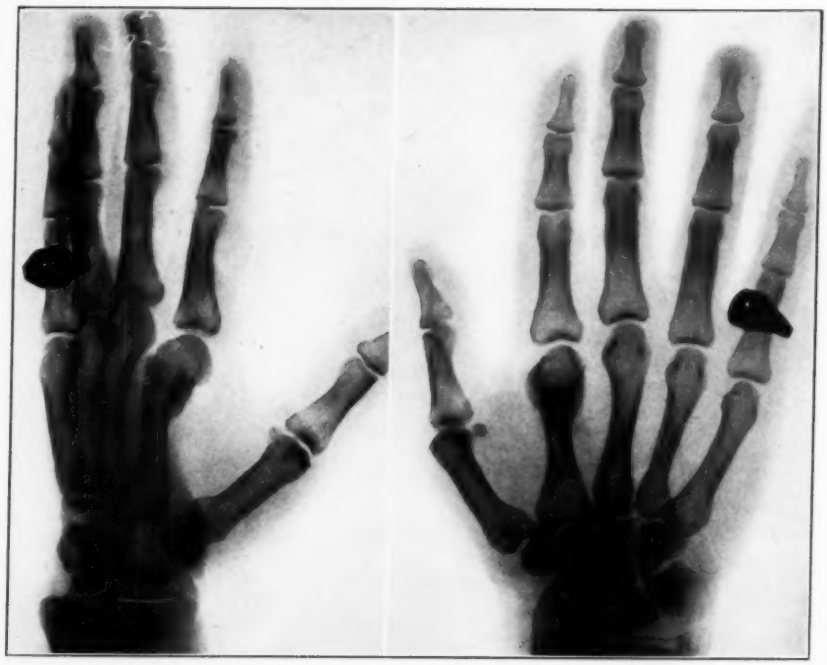

FIG. 7-A

Case 8. Old malunited fracture of the index metacarpal with marked dorsal angulation. Note shortening of the entire metacarpal.

FIG. 7-B

Case 8. Note shortening of the metacarpal. Compare with Fig. 8-B.

that is necessary for the alignment of the distal fragment is the arc of the angulation between the fragments. In the ring and little fingers this excursion is necessarily greater, since not only must the angulation of the fragments be overcome, but, in addition, the arc of extension traversed by the proximal fragment before it becomes fixed at the carpometacarpal joint. However, should the proximal fragment be fixed mechanically, no consideration need be given either to the presence or the absence of motion in this joint. This would make the problem of reduction and immobilization uniform for all fractures of these metacarpals.

PREREDUCTION REQUISITES

1. *Reduction of either overriding or lateral displacement must first be done.* Traction, countertraction, and manipulation, with the entire finger in *flexion*, usually produce the desired effect.

2. *Should the fracture be an impacted one, it is absolutely imperative that it be broken up. The distal fragment must be freely movable before either correction of the angulation or immobilization is attempted.*

REDUCTION AND IMMOBILIZATION

Since reduction is so intimately associated with the immobilization, these two procedures will be discussed together.

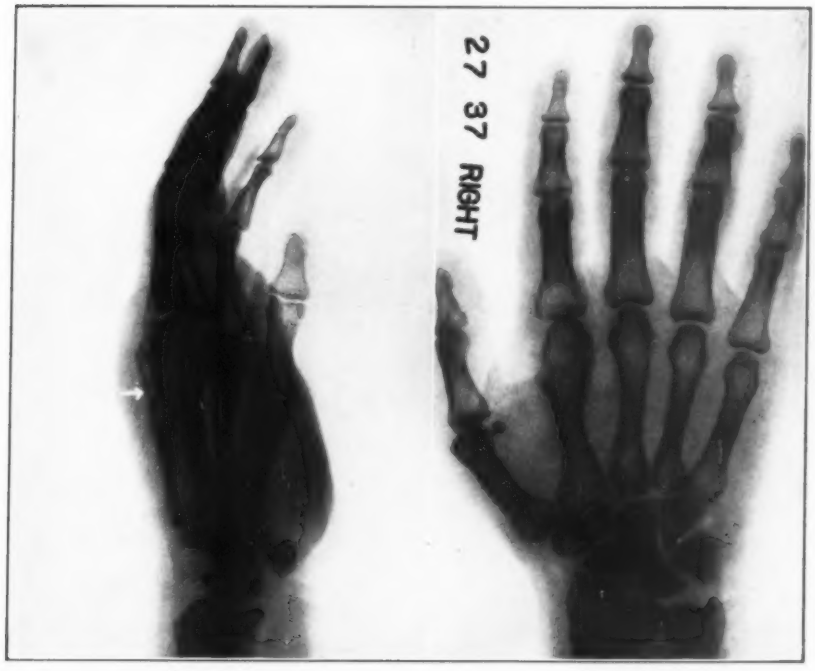

FIG. 8-A

Case 8. Complete correction of the dorsal angulation by the author's method, following preliminary osteotomy.

FIG. 8-B

Case 8. Note the lengthening of the metacarpal. Compare with Fig. 7-B.

Immobilization is done in two stages:

First Stage

A strip of heavy piano felt, one inch wide and about ten inches long, is split into two equal thicknesses. After one edge of one strip has been beveled off, the strip is laid across the dorsum of the hand, just proximal to the fracture line, with the unbeveled edge facing the fracture. Since all the counterpressure will take place at this point, it is necessary to pad this part more heavily. The redundant portion of the felt is cut away. One layer of thin, white, tailor's felt is then applied to the hand, from the unbeveled edge of the heavy felt to about three or four inches above the wrist. (See Figure 9-A.) A plaster-of-Paris dressing is next applied to this part of the hand, supplemented with a narrow reenforcement, placed transversely across the dorsum of the hand and overlying the heavy felt. (See Figure 9-B.) This reenforcement assures the maintenance of the counterpressure. The initial plaster dressing fixes the proximal fragment, eliminating the factor of motion at the carpometacarpal joint.

The finger of the involved metacarpal is now flexed at the metacarpophalangeal and proximal interphalangeal joints to an angle of 90 degrees. The distal interphalangeal joint is permitted to remain in extension. With the finger in this position, the second piece of heavy felt is placed over it, from the unbeveled edge of the heavy felt on the dorsum of

FIG. 9-A

Note position of the heavy felt behind the knuckles and just distal to a fracture of the neck of the fifth metacarpal. It is held in position by one layer of tailor's felt, which extends about four inches above the wrist.

FIG. 9-B

First section of the plaster-of-Paris dressing applied. The second piece of heavy felt has been placed over the flexed finger and strapped to the plaster dressing. The metacarpophalangeal and proximal interphalangeal joints are in 90 degrees of flexion. The distal interphalangeal joint is in full extension.

FIG. 10-A

Note how extension of the distal fragment is obtained through the flexed finger. The palm of the hand is pressing upward on the plaster reenforcement covering the finger from its tip to the flexed proximal interphalangeal joint. Note also that the surgeon's other hand steadies the initial plaster while the upward pressure is taking place. The position of the two hands remains the same until the reenforcement is incorporated in the initial plaster and the entire plaster dressing is set.

the hand to a point just beyond the finger tip. A long adhesive strip holds it in place.

Second Stage

One end of a slow-setting plaster-of-Paris reenforcement (one quarter of an inch thick,

FIG. 10-B

Plaster-of-Paris dressing completed. Dorsal view. "Free knuckles" permit extension of other fingers.

FIG. 11-A

Lateral view. The finger can be inspected easily. The wrist is fixed in about 5 degrees of extension.

FIG. 11-B

Finished plaster dressing. Note freedom of the thumb and the other fingers for flexion.

one inch wide, and about fourteen inches long) is placed on the palmar aspect of the first plaster, four inches proximal to its distal edge, along the extended distal interphalangeal joint to the flexed proximal interphalangeal joint. With the palm of the hand, gentle upward or dorsal pressure is exerted on the reenforcement covering this part of the finger (from its tip to the flexed proximal interphalangeal joint), with most of the force at the flexed proximal interphalangeal joint, until the dorsal angulation is overcome. (See Figure 10-A.) Once this is accomplished, the pressure remains constant to maintain the correction. An assistant then quickly brings the remainder of the reenforcement over the proximal phalanx and the knuckle, and, finally, onto the dorsal aspect of the first plaster for a distance of about three or four inches. The reenforcement is then immediately incorporated in the first plaster with one plaster bandage by including only those parts which overlap the first plaster. (See Figures 10-B, 11-A, and 11-B.) The dorsal or upward pressure is not released until the entire plaster is thoroughly set.

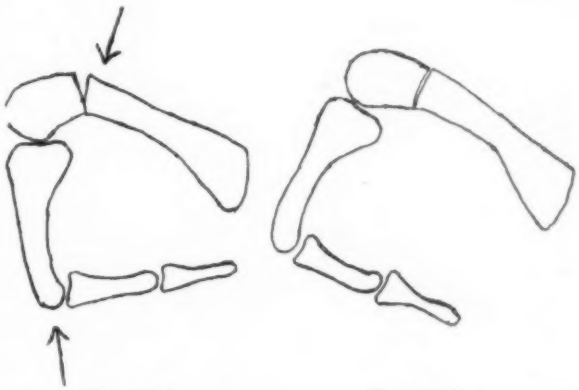

FIG. 12-A FIG. 12-B

Fig. 12-A: Before reduction. Upper arrow shows the downward thrust exerted by the edge of the initial plaster dressing. The lower arrow shows the upward or dorsal thrust by the long plaster reenforcement.

Fig. 12-B: After reduction. Showing correction of the dorsal angulation, the resultant action of the two forces.

At times, due to the motion present in the carpometacarpal joint of the fifth finger, ulnar deviation of the distal fragment takes place. This is easily controlled by extending the transverse dorsal plaster-of-Paris reenforcement over the sides of the index and little fingers, following manual correction by radial pressure.

A word of caution is necessary. The second section of the plaster should not be applied unless the distal fragment is freely movable. When such is the case, very little force is necessary to produce perfect alignment. Should this precaution not be taken, then the amount of force necessary to correct the angulation is such that a pressure sore will undoubtedly develop over the proximal interphalangeal joint. The development of an area of local skin necrosis does not, by any means, presage a poor result. It merely prolongs the treatment.

AFTER-CARE

Immobilization for two and one-half weeks is usually sufficient. Massage, local heat, and exercises are indicated. Most important of these are the active and passive exercises.

There is always some fixed flexion present at the metacarpophalangeal and proximal interphalangeal joints when the plaster is removed. It is much more pronounced in the latter joint. This is due to periarticular adhesions, which must be thoroughly broken up. It is the author's practice to do this at the time when the plaster is removed. When the joints are gently extended by the surgeon at this time, a sudden give will be felt soon after the inception of this passive motion. As soon as this takes place, full extension is rather easily accomplished. Subsequently, complete passive flexion and extension are carried out daily until such time as the patient can actively flex and extend these joints within the normal range. Immediately after the first manipulation, the patient has no power of extension in the proximal interphalangeal joint. The finger hangs limply at this joint and one may become concerned over this absence of function. Within one or two days the power of extension returns. The patient is instructed to move these joints actively and passively many times a day.

Too much stress cannot be placed on the importance of the after-treatment. An excellent result, with no restriction of motion, can be expected, if diligent and painstaking physiotherapy is carried out. Otherwise, some restriction of extension is the rule. This restriction of motion, strange to relate, is usually at the proximal interphalangeal joint and not at the metacarpophalangeal joint. Why it should affect a joint not even close to the fracture, while the joint actually at the fracture site remains free, is a phenomenon for which no explanation is offered.

The present series comprises ten cases. Of these, nine were recent fractures and one was an old malunited fracture. (See Figures 7-A and 7-B.) In this last case, an osteotomy through the angulation was done, and the case was treated as if it were a recent fracture. (See Figures 8-A and 8-B.)

The results in the ten cases have been uniformly good.

SUMMARY

Fracture of any one of the four inner metacarpals can be reduced by upward or dorsal pressure on the flexed distal fragment, with the metacarpophalangeal and proximal interphalangeal joints of the involved finger held at 90 degrees of flexion. This position at the metacarpophalangeal joint relaxes the interosseous muscles and at the same time tenses the collateral ligaments, permitting extension (correction of the angulation) of the distal fragment through upward or dorsal pressure on the flexed proximal interphalangeal joint. This correction can be best maintained if the plaster-of-Paris dressing is applied in two sections: the first, to immobilize the proximal fragment; and the second, to maintain the correction.

The author wishes to express his thanks to Dr. S. Kleinberg and Dr. H. Lusskin who treated Cases 8 and 7 according to his method.

ADAMANTINOMA OF TIBIA

Report of a Case *

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The adamantinoma, an epithelial tumor long recognized as arising in the jaw and in the hypophysis cerebri, is known also to occur in a third location,—namely, the tibia. Fischer first described such a tumor of the tibia in 1913. Not until 1930 was a second case described by Richter, and since then four more cases have been recorded by Baker and Hawksley, Ryrie, Holden and Gray, and Bishop. It is the purpose of this paper to report the clinical and pathological aspects of an additional case.

CASE REPORT

R. S., a Jewish housewife of twenty-four years, entered St. Vincent Charity Hospital on October 14, 1936, complaining of pain in the left ankle. She had sprained the ankle

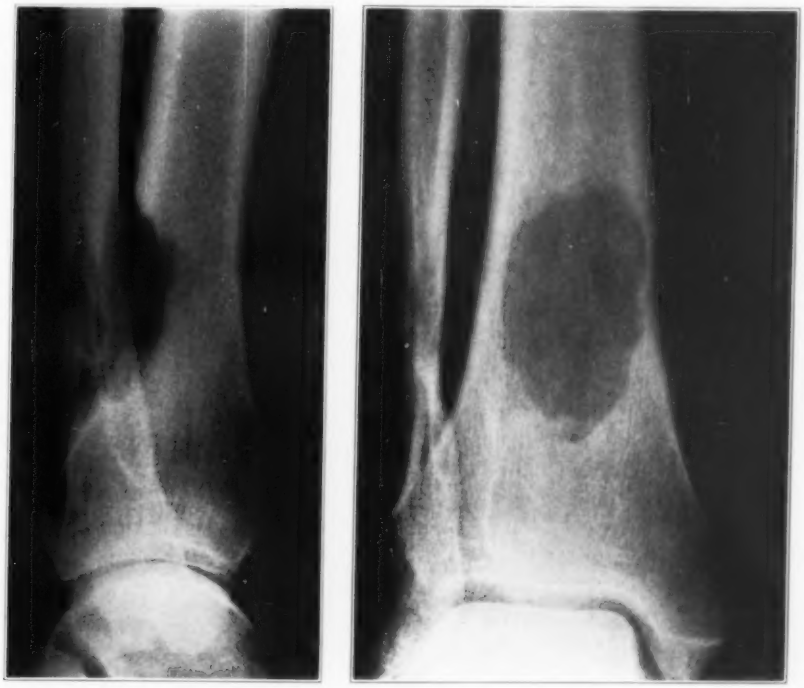

Fig. 1-A Fig. 1-B

Roentgenograms of left tibia, showing character of bone involvement.

* Received for publication May 11, 1937.

eighteen months previously and since that time had had slowly progressive difficulty in walking.

Examination showed an obese woman who limped. On the medial aspect of the lower third of the left leg there was a rounded, tender, slightly fluctuant, subcutaneous mass, approximately six centimeters in diameter. This was fixed to the tibia, but not to the skin. The overlying skin was elevated one and five-tenths centimeters above the surrounding skin surface, but was not discolored.

Roentgenograms showed a cavity, four centimeters in length and two and three-

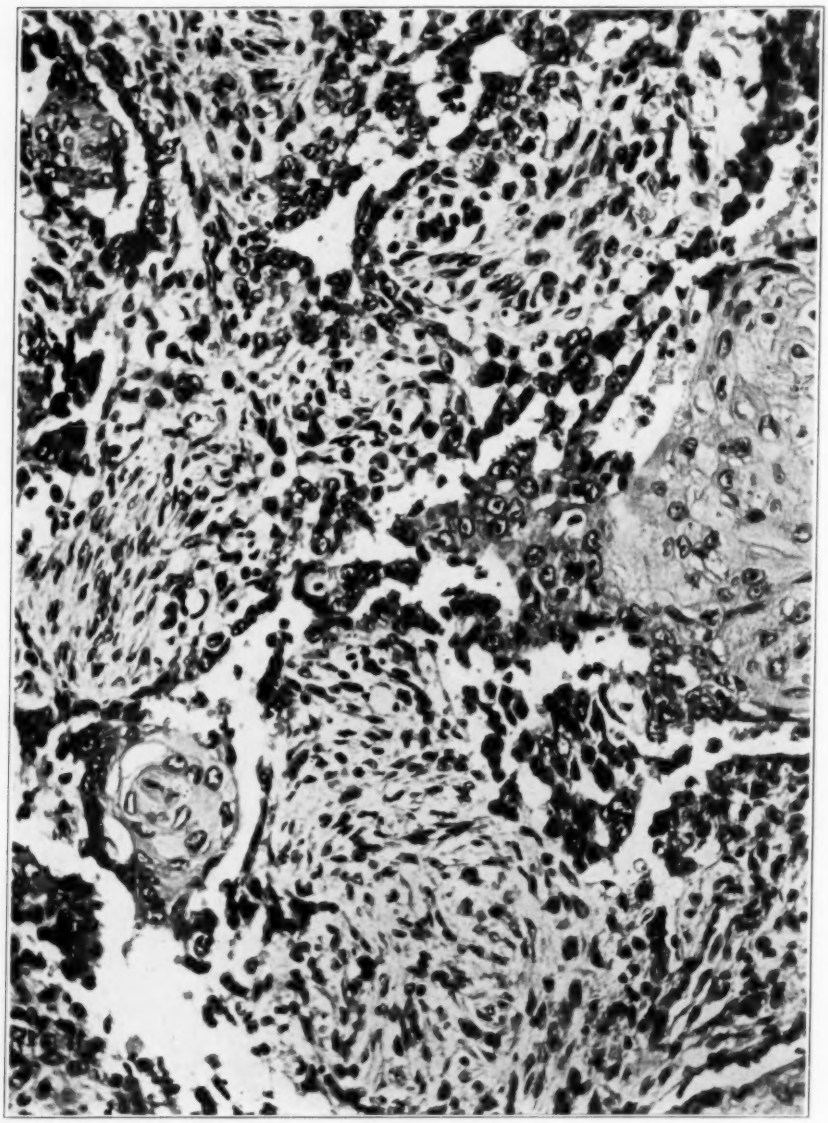

FIG. 2

Photomicrograph (× 200) of tumor, showing areas of cystic degeneration surrounded by rows of cuboidal epithelial cells. Squamous type of epithelium on right.

tenths centimeters in diameter, situated in the lower third of the tibia with its lower margin two and five-tenths centimeters above the articular surface. The borders of the cavity were regular and sharply outlined, and there was no reaction in the surrounding bone. The cavity had broken through the cortex posteriorly. The periosteum was slightly thickened from the internal malleolus upward for eight centimeters over the medial and anterior surfaces of the tibia. The lesion was interpreted roentgenographically as a Brodie's abscess, particularly because of the sharp limitation of the borders of the cavity and the inflammatory type of periosteal thickening.

At operation on October 15, 1936, the presenting portion of the lesion was found to

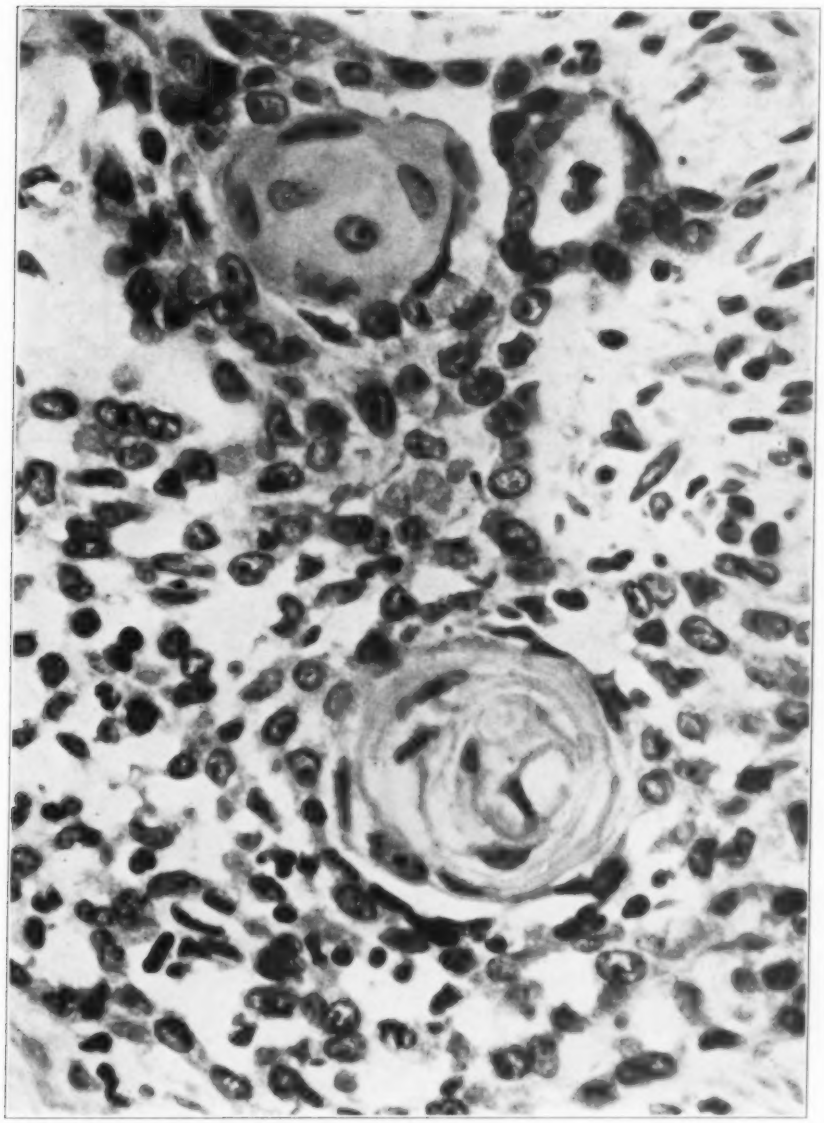

FIG. 3

Photomicrograph (× 480) of tumor, showing epithelial pearls.

TABLE I

ANALYSIS OF REPORTED CASES OF ADAMANTINOMA OF THE TIBIA

Case	Author and Year	Age (*Years*)	Sex	Site	Symptoms	Duration of Symptoms Prior to Operation	Preoperative Diagnosis	Operation	Result
1	Fischer (1913)	37	Male	Left tibia	Pain and swelling	5 months	Primary tumor	Tibial resection and bone graft	
2	Richter (1930)	12	Male	Left tibia, middle third	Swelling	8 months	Myelogenic sarcoma	Amputation	
3	Baker and Hawksley (1930)	46	Male	Left tibia, lower third	Pain	6 weeks	Myeloma	Subperiosteal resection of 4-inch segment of bone	
4	Ryrie (1932)	44	Male	?	Pain and tenderness Swelling	16 years 8 years	Bone sarcoma	Tumor curetted out	Recurrence in 6 months. Amputation.
5	Holden and Gray (1934)	36	Female	Left tibia, lower third	Pain	2 years	Bone cyst	Wide local excision	Recurrence in 2 years.
6	Bishop (1937)	22	Male	Right tibia, upper third	Swelling	3 years	Bone cyst or giant-cell tumor	Curettage and cauterization	Recurrence in 14 months. Amputation.
7	Rehbock and Barber (1937)	24	Female	Left tibia, lower third	Pain	18 months	Brodie's abscess	Wide local excision	

have a thick fibrous capsule which fused with the adjacent tendons and muscle. Incision through the capsule showed one large cavity and several small cavities filled with a thin, clear, straw-colored fluid. The outer wall of the mass contained no bone and it was removed for pathological examination. On October 20, 1936, the involved tissues were widely excised, leaving a narrow bridge of healthy tibial shaft. The wound healed rapidly, and the patient was discharged in eleven days, wearing a cast. Subsequent roentgenograms of the skull showed no evidence of tumor in the jaws or pituitary fossa. On June 19, 1937, eight months after operation, there was no roentgenographic evidence of tumor recurrence in the leg.

Pathological Examination: The biopsy specimen on October 15, 1936 consisted of a single piece of firm, pale tissue, measuring three and five-tenths by two and five-tenths centimeters by one centimeter. This was covered over one surface by a fibrous membrane representing the external capsule of the tumor. The tissue was dense, firm, and tough, but contained no cartilage or bone. The specimen removed on October 20, 1936 consisted of sixty grams of fragmented bone and soft tissue.

Microscopic examination showed dense fibrous connective tissue, throughout which were irregularly disposed epithelial masses. In some situations these epithelial masses were characterized by a peripheral single layer of small cuboidal cells, followed within by flat or polygonal cells. More centrally, these masses showed hydropic infiltration with nets of polygonal, stellate, or branching cells. Cystic spaces were present in some areas. There were epithelial pearls with and without keratinization, some showing calcification. In many areas compact epithelial cells without architectural arrangement were disposed without sharp demarcation from the fibrous stroma. The bone adjacent to the soft tissue tumor showed degeneration of bony trabeculae, fibrosis of marrow spaces, and irregular penetration by the tumor for a short distance.

COMMENT

That a tumor producing the essential features of the enamel organ should occur as a primary tumor in the lower third of the tibia seems bizarre. Malassez's theory as to the origin of the adamantinoma of the jaw is acceptable, as is pointed out by McFarland and Patterson in their thorough review of the subject of adamantinomata. According to this theory, the tumor in the jaw arises from atrophic or isolated groups of epithelial cells about the roots of the teeth. The adamantinoma of the hypophysis originates in epithelial remnants of the hypophyseal duct. The origin of this tumor of the tibia, however, is less clearly explained. Fischer assumed that it originated from a foetal cell rest formed during the intra-uterine period. Baker and Hawksley followed Fischer in postulating a foetal epithelial rest, but laid some stress on trauma as stimulating the rest into growth. Ryrie also emphasized the etiological importance of trauma, but believed that the growth arose from epithelium implanted at the time of injury.

There is no doubt concerning the identity of these tumors with those of the jaw and the hypophysis. As was pointed out by Duffy, adamantinomata of whatever location produce a structure which tends to reproduce the essential features of the enamel organ. The columnar peripheral layer of the neoplastic epithelial processes corresponds with the so-called "inner layer" (of adamantoblasts) of the enamel organ, the subcolumnar transitional zone of vesicular epithelial cells with the "intermediate zone," and the reticulated hydropic central zone of stellate epithelial

cells with the enamel pulp or middle zone of the enamel organ. The slow rate of growth, cystic degeneration, tendency to recur after local excision, and failure to metastasize are characteristic of these tumors whether in the jaw, the pituitary body, or the tibia.

The diagnosis of adamantinoma of the tibia can be made only by histological examination. However, the characteristic location, the history of trauma followed by a latent period and then by pain, and a roentgenographic picture of a sharply outlined area of bone destruction should lead one to consider the possibility of adamantinoma. Once the diagnosis is established by biopsy, the operation of choice is resection of the shaft of the tibia, followed by a bone graft. In doing the resection one should keep well above and below the tumor area. Local resection of the tumor with the chisel and curette in three of the previously reported cases was found to be inadequate.

Grateful acknowledgment is made to Dr. Francis Carter Wood for the photomicrographs which accompany this case report.

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TENDON TRANSPOSITION

An End-Result Study *

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INTRODUCTION

In presenting this paper, the writer assumes at the outset that it would, to the majority of orthopaedic surgeons, be unnecessary and superfluous to demonstrate the proposition that tendons or muscles can be transposed to a new site and function in a new direction, even though this elementary fact may not have unanimous recognition.

On the other hand, the writer, from his own clinical experience plus observations of this phase of surgery in many different localities over a period of nearly twenty years, is very definitely of the conviction that a wider application and a more satisfactory achievement in the ultimate functional result would obtain through appreciation and acceptance of certain precise and standardizable indications for the utilization of this type of surgery. It is his impression that the modern orthopaedic surgeon with good basic surgical technique and understanding of the principles of tissue physiology and healing, established long ago by Lange, Biesalski, and Mayer, can quite uniformly produce a functioning tendon transplant. That the procedure has been too often disappointing to patient and surgeon in its ultimate benefit and has as a result a minority of enthusiastic adherents is due, the writer believes, to an inadequate recognition and appreciation of the part played by certain physical principles in the selection and indications for the procedure. Its greatest field is, of course, the disabilities residual from anterior poliomyelitis; yet the unequal distribution of this disease restricts the practical experience of surgical rehabilitation to a comparatively few surgeons. At the same time, while much has been written relative to the technique and results of certain specific operative procedures, there is little or nothing of importance on the phase of selection and indications, and particularly on the physical factors involved, in our literature (textual or current) since the early work of Lovett.

The possibility of a somewhat authoritative contribution on this subject arises from a body of clinical material under the writer's control during the last ten years which has provided opportunity for about 300 operations for tendon transposition, 240 of which were performed more than three years ago. Of these 240 patients, 215 were examined for results after such an interval. As to the question of obtaining a working

* Presented before the American Academy of Orthopaedic Surgeons, Cleveland, Ohio, January 12, 1937.

or functioning muscle after transposition, some postoperative observations prevail on the entire 300, with positive findings in 92 per cent. Of the 215 patients checked up at periods of from three to ten years after operation, a strongly working transplant was observed in 90 per cent. Of the total cases, a considerable number represented a variety of types of paralytic residuals, of which no one group was sufficiently large to warrant dogmatic conclusions; but there remained several different situations in which the experience seemed adequate to make quite positive predictions as to indications and results.

DISCUSSION

Inasmuch as in this study sufficiently extensive evidence from the statistical angle is limited to work on the lower extremities, discussion will be restricted to this phase. However, it is here that what the author regards as the key considerations are most particularly involved. The foremost of these is the necessity of determining to what degree the disability or deformity is static (negative) and to what degree it is dynamic (positive). The most obvious example of dynamic deformity is the calcaneus foot; of static deformity, that planovalgus foot which, more or less flail, is without any power in the invertors. In the former instance, no amount or extent of arthrodesis alone will prevent in the growing child a recurrence of deformity. In the latter instance, fusion and block procedures readily eliminate all further concern about deformity.

Other situations are not so simple, and we must realize that dynamic instability is always present to some degree whenever the antagonists of any weakened muscle group are strongly active. For instance, when the invertors of a foot are inadequate to static stress, the planovalgus deformity will include a static element, but, if the peroneal group is strongly active, a dynamic element is added, which, if overlooked, will spoil the result of any arthrodesis. While the drop-foot equinus element of the flail foot is a negative or static one, it is not difficult to control by corset shoe, brace, tenosuspension, or bone block. On the other hand, the equinus element of a foot with impaired dorsiflexors and strong plantar flexors tends to overcome any measures of control as long as the dynamic imbalance of unopposed calf-muscle groups remains.

Accordingly, we can establish two primary postulates. The first is that essentially dynamic imbalance is an imperative indication for "redistribution", a reconstructive procedure, with experience showing that transposition can be so adapted as to restore both balance and adequate function, often without necessity for sacrifice of normal mobility. The indication has no limitation to any age period, for, even if entirely complete stability may not in certain situations obtain from redistribution alone, deformity becomes easily preventable by minimal support until an appropriate age for some limited joint fusion is reached. When an imperative indication for redistribution by tendon transposition is also accompanied by additional need for joint fusion, there is no contra-indi-

cation for combining the two types of procedure at one operation if the age is appropriate. The second postulate is that, for essentially static deformity, tendon transposition as a rule will not suffice, and joint fusion will be necessary; but, in contrast to dynamic deformity, static deformity is easily susceptible of mechanical control during the period prior to the applicability of bony stabilization. Thus, procedures of tendon transposition may be undertaken with one of three distinct aims: (1) purely to restore a lost functional capacity, mainly applicable to the upper extremity; (2) to remedy a positive or dynamic imbalance by a balanced redistribution; and (3) to remedy a static imbalance by tendon transfer alone (biceps transposition at the knee).

The second key consideration is the evaluation of the muscle which suggests itself for tendon transposition, both as to its state of efficiency and as to its physiological adaptability. At the outset, it should be stated that the necessity of complete reversal to an opposite function is no contra-indication to selection; re-education may be slower, but, if other principles are observed, an effective reversal of function can be expected. On the other hand, any degree of paresis or weakening is a contra-indication if the primary purpose of the transposition is to replace a wiped-out muscle or group of muscles. A subnormal muscle may still be selected for transfer when it is a factor in dynamic instability if this is the primary consideration, or when its transfer places it in combination with another only slightly subnormal but inadequate muscle or group. Finally, its physiological action must be considered. A short-bellied, short-excursion, steady-pull muscle is not adapted to replace the opposite — that is, the strap-type, long-excursion, light-load muscle—and *vice versa*. It should, of course, go without saying that accurate testing and rating of all muscle groups of the affected part are essential for any proper evaluation of the presenting situation and the possibilities for its relief. In the analysis of the clinical material which has led to the establishment of specific indications, a grouping into five basically different types of imbalance has been done.

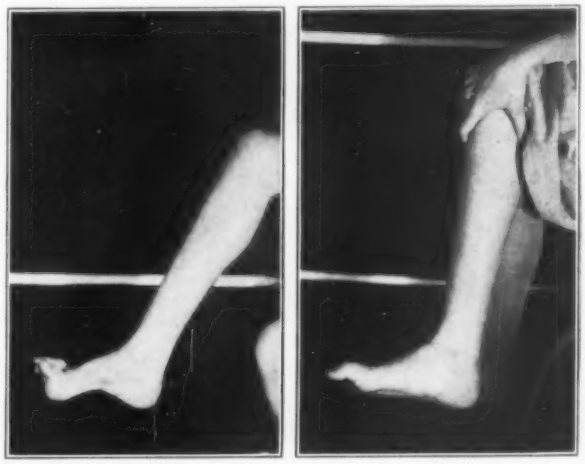

FIG. 1–A FIG. 1-B

Fig. 1-A: Typical early diagnostic complex of isolated weakness of tibialis anterior. On dorsal-extension effort, the foot goes into the clawed position and remains in plantar flexion; on weight-bearing, the foot is in planovalgus.

Fig. 1-B: Balanced control after proximal transposition of extensor hallucis longus.

GROUP I—LIMITED EXTENSOR-INVERTOR INSUFFICIENCY

Forty-three cases are available in which a specific transposition was done for this precise type of residual imbalance, consisting of isolated paralysis or notable weakness of the tibialis anterior muscle. The functional defect here is often not apparent early, and deformity is often slowly progressive. The reliable diagnostic complex is a foot in which the effort at dorsiflexion is found to be inadequate with the toes retracting and the foot going into cavus as the effort is made, and in which either permanent equinus or limitation of passive dorsiflexion prevails (idiopathic claw-foot being ruled out by the finding of absent or weak effort in the tibialis anterior). As a rule, on weight-bearing these feet take a planovalgus position, but this group includes some cases which showed no pronation but did have contracture of plantar fascia and moderate cavus. From the angle of muscle-testing, the author has found no explanation of these two different types. Compensation or substitution for the tibialis-anterior inadequacy of course takes place by excessive effort with the common digital extensor and with the proper extensor of the big toe. The writer's impression is that the individual who strives as long as possible to improve this substitution by fixing the toes with their flexor mechanism develops a straight equinus with cavus; in the others the foot assumes the position of planovalgus. In both positions there prevail elements of both static and dynamic imbalance.

In all forty-three cases, restoration was attempted by transposition of the tendon of the strong extensor hallucis longus from its relatively ineffective insertion in the toe to one in the foot itself, usually at the base of the first metatarsal. Save for plantar fasciotomy, nothing else was included in the operation in the cavus type, and both posture and dorsi-

FIG. 2-A FIG. 2-B FIG. 2-C

Complete loss of both tibials, and marked toe-extensor weakness.
Fig. 2-A: Extreme dynamic planovalgus, associated with drop-foot.
Figs. 2-B and 2-C: After operation for forward transposition of both peronei plus Hoke reconstruction of skeletal deformity.

flexion were satisfactory in all. In the other type, when the planovalgus was moderate and easily correctable, this tendon transposition alone gave a high percentage of satisfactory results, both as to statics and to extensor function. In the presence of severely relaxed or fixed planovalgus, an astragalonavicular arthrodesis was combined with the tendon transposition.

The whole series of forty-three cases were analyzed from the standpoint of (1) extensor function and (2) posture. In regard to the former, adequate function prevailed in thirty-four, was improved in eight, and was unchanged in one. Restudy of the last case indicated an original rating of some impairment of the extensor hallucis longus which, in the absence of an active tibialis anterior, should have ruled this case out of this group. In all instances but one, those cases in which function was improved but not adequate had presented with a recurrent equinus after lengthening of the Achilles tendon done elsewhere. In this whole group, contracture of the Achilles tendon was overcome before operation when possible by gradual stretching, and the only cases in which it was not possible and in which tenotomy was required were those of prior lengthening of the Achilles tendon. In respect to posture, twenty-nine patients had good posture; nine, fair; and five, poor (pronation). Analysis of these last five cases revealed two in which an overlooked impairment

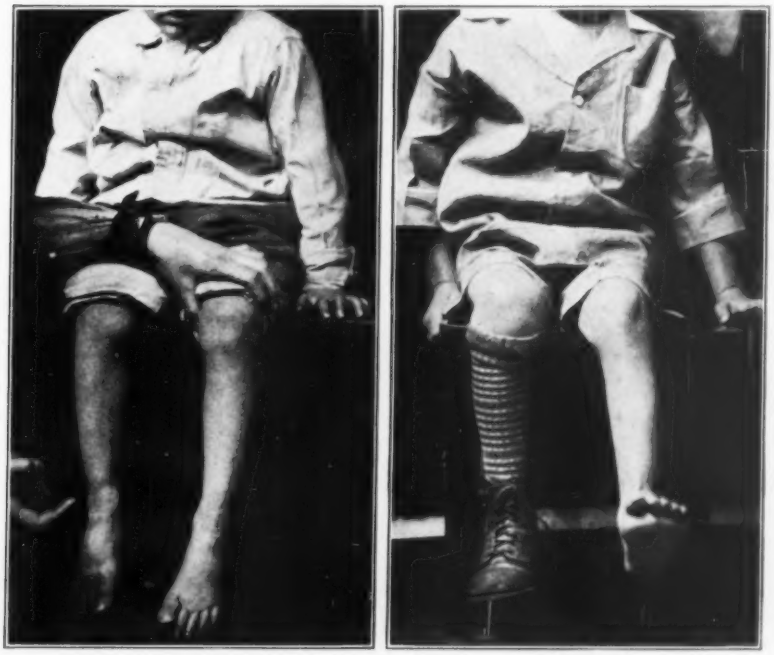

FIG. 3-A FIG. 3-B

Complete loss of dorsal extensors with weakness of invertors.
Fig. 3-A: Function before operation.
Fig. 3-B: Function after forward transfer of both peronei. No arthrodesis was done. Note neutral posture of foot.

of the tibialis posterior prevailed, and three in which a fusion failed to consolidate, having been done at too early an age.

Accordingly, we have a partly dynamic and partly static situation, in which subtraction from the dynamic side is not necessary, and in which balance and stability can be restored either by transposition alone of the extensor hallucis longus or by a combination of this procedure with astragalonavicular arthrodesis according to the prevailing conditions, the presenting pattern being an extensor-invertor insufficiency from residuals limited to the tibialis anterior muscle.

GROUP II—GROSS EXTENSOR-INVERTOR INSUFFICIENCY

There were fifty-four cases which fell into this classification by reason of their having notable impairment of the toe extensor musculature in addition to impairment of the tibials. The appropriate indications for tendon transposition required further subdivision into two types, A and B.

FIG. 4-A

FIG. 4-B

Fig. 4-A: Complete drop-foot and beginning cavus resultant from extensive dorsiflexor insufficiency (incomplete for toe extensors).

Fig. 4-B: Active dorsiflexor capacity in stable foot five years after forward transposition of peroneus longus. No arthrodesis was done.

Type-A cases showed extensor inadequacy of drop-foot equinovalgus character, due to weakness or paralysis both of the toe extensors and of the tibialis anterior, but without more than one-grade weakness of the tibialis posterior, the rest of the musculature being normal. In this type of imbalance, if redistribution is done relatively early, there is required nothing more than transposition of the peroneus longus to the dorsum of the foot. Quite a long time ago the author discontinued the technique of transposition completely across into the sheath and the insertion of the tibialis anterior, because, although very adequate dorsiflexion uniformly followed, it sometimes reversed the invertor-evertor imbalance and left the foot unstable in varus, a condition which was found to be obviated by locating the insertion of the transplant at the dorsal aspect of the mesial cuneiform. Transposition was done in twenty cases, in nineteen of which adequate restoration of extensor control resulted. Arthrodesis, usually astragalonavicular, was done only in those cases in which prior to operation deformity had continued until structural changes prevented satisfactory realign-

ment; however, in about half of these cases this procedure was necessary. Poor statics resulted after operation in only one of the twenty cases.

Type-B cases were those showing severe impairment of both tibials, as well as of the toe extensors, and transposition of both peronei to the dorsum of the foot was done in thirty-four cases. Adequate extensor function prevailed in thirty-two. Study of the two failures showed that in one case transposition of a peroneal group definitely rated as weak had been done, and in the other infection had occurred. As would be expected, preoperative structural deformity was severe in the long-standing cases, necessitating the Hoke procedure at the time of transposition in twenty-three cases, all of which on check-up showed satisfactory statics. In eleven cases, the transposition was done at an age prior to the applicability of arthrodesis, but on check-up none of these showed inadequate lateral stability, with posture or statics excellent in eight. The writer believes that, if in these early cases the patients continue to wear ankle-high shoes until maturity, arthrodesis for lateral instability will not be necessary.

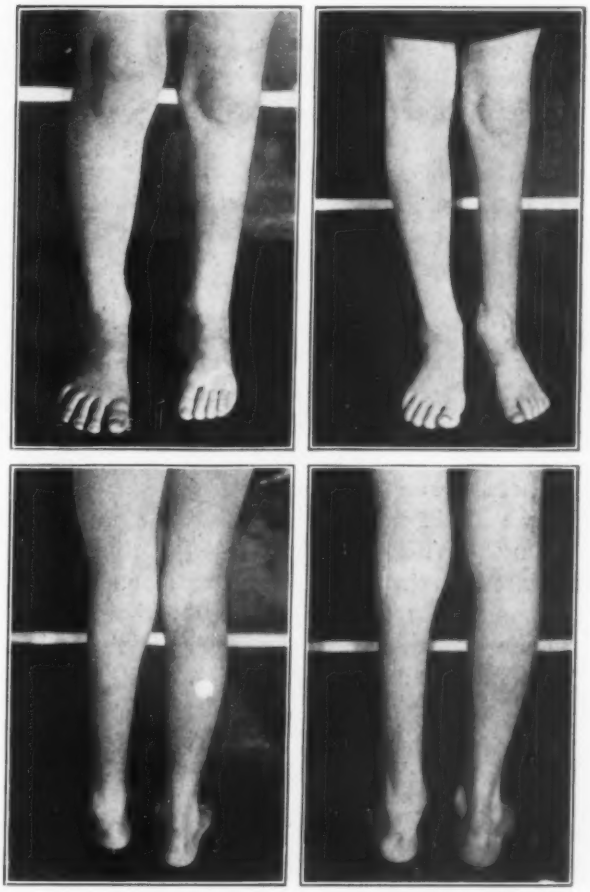

FIG. 5

Anterior and posterior views before and after outward transposition of tibialis anterior tendon for varus instability due to peroneal insufficiency.

In summary of Group II (one or both peronei forward), adequate functional control prevailed in fifty-one out of a total of fifty-four cases, with satisfactory statics in fifty-three; some type of fusion procedure was added in thirty-four. Group II must be considered as being composed mainly of cases of dynamic imbalance, the presenting pattern being equinovalgus from residual extensor-invertor paralysis.

GROUP III—EVERTOR INSUFFICIENCY

Compared with the other groups, this was a small one, there being only eleven cases. In the earlier years covered by this study, bony stabilization alone was applied to this type of imbalance—namely, loss of power of the peronei, with musculature otherwise normal—but recurrent varus deformities brought the realization that redistribution should be attempted in this pattern also. The operative procedure in the eleven cases consisted of lateral transposition of either the extensor hallucis longus or the tibialis anterior. If the situation showed a slight peroneal impairment, or moderate impairment plus slight weakness of the tibialis posterior, the extensor hallucis longus was transposed to the base of the fifth metatarsal. In instances of greater impairment, the tibialis anterior was transposed to the cuboid and the extensor hallucis longus to the first metatarsal. Balanced extensor function prevailed in all cases; stability and posture were good in seven, fair in three, and poor in one. This particular group was made up entirely of fairly young children and no bony stabilization was added. When a complete loss of power of the peronei prevails, and a normal tibialis posterior persists, greater security against varus imbalance can be obtained by adding tenotomy of this tibial. Long-standing varus instability with advanced deformity will always require the addition of the Hoke procedure, but instability at the ankle joint will eventually develop if this method alone is relied upon. The condition must be regarded as a purely dynamic instability.

GROUP IV—TRICEPS SURAE (TENDO ACHILLIS) INSUFFICIENCY

The author suspects that all orthopaedic surgeons will regard the dynamic calcaneus foot as the most grievous of all types of muscle imbalance, both in the disturbance of gait, the deforming tendencies, and the difficulty of control; and that they also will agree that a foot free from deformity with a pan-arthrodesis in slight equinus position is vastly preferable to calcaneus instability. However, if this imbalance occurs in a small child before the age when such a type of arthrodesis is feasible, the writer does not believe that any appliance will prevent the development of severe deformity. When this deformity is corrected by the necessary bone resections, a badly maimed foot results. The author has seen too many recurrent calcaneus or calcaneocavus deformities after bony procedures done before maturity to have much faith that any such procedure alone can be permanently successful in the face of persistent dynamic imbalance. As far as the age of applicability is concerned, the same argument prevails for control by Achilles tenodesis.

On the other hand, the writer is convinced that appropriate redistribution at an early post-paralytic stage (two to three years) will prevent progressive deformity, but at this point he wishes to state that the only redistribution which he has found to restore completely a heel-and-toe gait and tiptoe capacity is the transposition of the tibialis anterior through the Achilles tendon to the os calcis. However, his experience with this

procedure has been limited to eight cases, only half of which have passed the three-year period. Although so far it has proved satisfactory in restoration of tiptoe function, a more perfect balance might be secured by the additional transposition of the extensor hallucis longus, when this muscle is competent, to the dorsum of the foot.

The observations on this imbalance seem to indicate that a pure calcaneus deformity will result in a condition in which all muscle action is practically absent except that of the dorsal extensors. Isolated paralysis of the triceps surae muscle is regularly followed by a calcaneocavus deformity, a more dangerous one than a pure calcaneus deformity. Insufficiency of the Achilles group, combined with lateral imbalance, adds an element either of varus or of valgus instability.

Leaving aside the eight transpositions already mentioned, there were found available for analysis forty-five transposition operations for some type of calcaneus imbalance, which were subdivided into three groups. Inasmuch as in few cases were the patients able to walk on tiptoe after the procedure, the degree of restored balance was rated as follows: "adequate" when a semblance of heel-and-toe action prevailed and the plantar flexor power was as good or greater than that of the dorsal extensors; "improved" when these conditions were not obtained, but enough power was restored to prevent recurrence of the calcaneus; "failure" when the calcaneus imbalance recurred. The operation did not include any bone surgery in about one-third of the cases.

Type A included twenty-six cases in which the invertors also were impaired, with a calcaneovalgus imbalance from the normal peronei, the

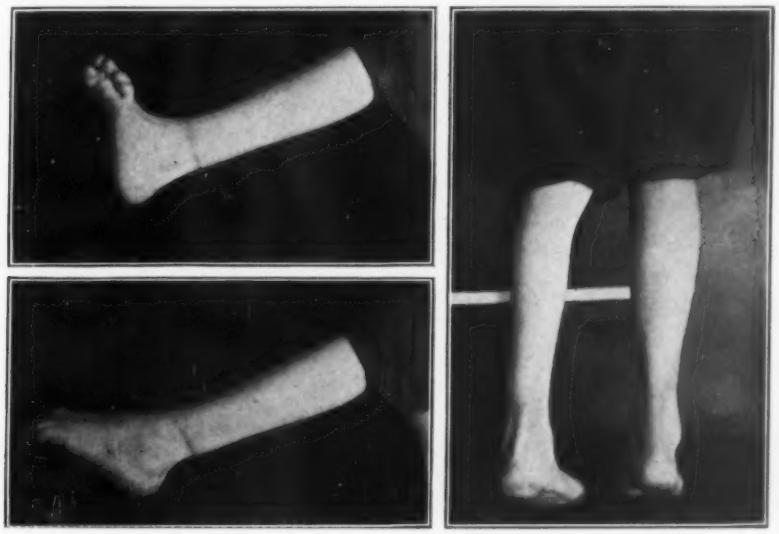

FIG. 6

After transposition of peronei to heel for calcaneus imbalance and weak invertors, showing result in active dorsiflexion, active plantar flexion, and tiptoe position. No stabilization was done.

latter being transposed to the os calcis. Results from the standpoint of function were: adequate, sixteen cases; improved, ten cases. The rating of statics and stability was as follows: of nineteen patients with tarsal fusion, the results were good in sixteen and fair in three; of seven without fusion (operation at an early age), the results were good in four and fair in three.

Type B represented eight cases with a combined varus imbalance from weak peronei, and transposition of the tibialis posterior, as well as of the flexor hallucis longus, was done. Results in respect to function were: adequate in five; improved in two; and failure in one. Posture and stability were good in all cases, but in all either tarsal arthrodesis was done to correct deformity or backward displacement of the tarsus was done to obtain greater leverage.

Type C, usually calcaneocavus deformity, numbered eleven cases. Since the secondary element of deformity was due to the presence both of strong invertors and evertors, the peronei and the tibialis posterior were

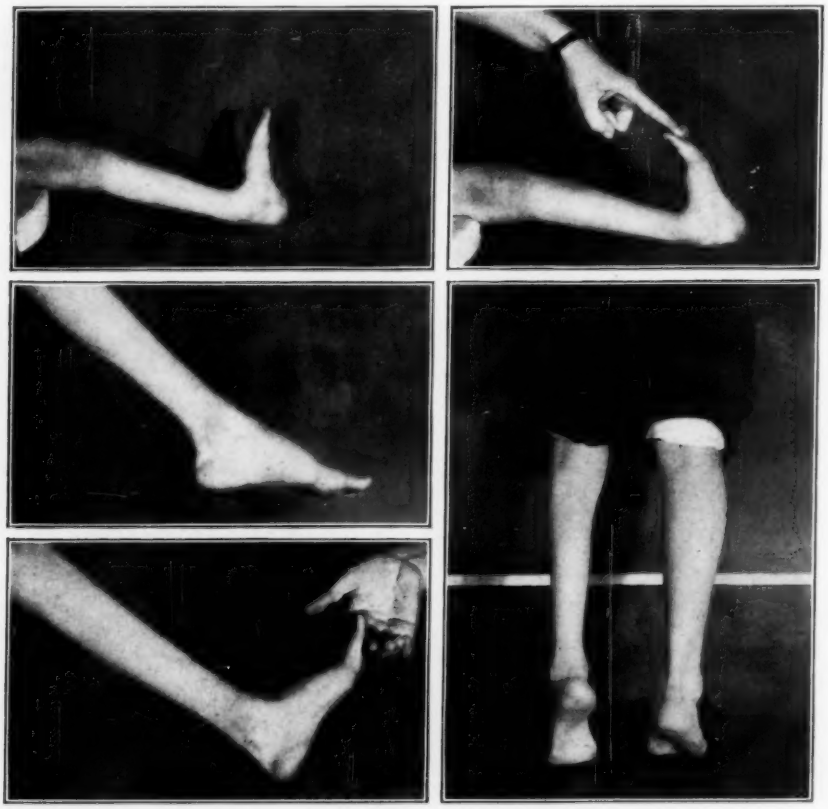

FIG. 7

Calcaneus imbalance from complete loss of all leg muscles except the dorsal extensors; active and passive range before operation; active and passive range and tiptoe capacity several years after transposition to heel of tibialis anterior tendon. No arthrodesis was done.

transposed to the os calcis. Function was rated as adequate in seven cases and improved in four. Although in one of the former there was the nearest approach to tiptoe capacity of all, especial analysis seemed indicated from the fact that the functional capacity of this group of eleven, with double transfers, proved no better in rating than either of the two single-transfer groups. Study of this group brought out the fact that in the greater proportion of the cases advanced skeletal deformity was present, and, in spite of bony reconstructions, normal leverage was on the whole more difficult to obtain; thus, the increased power given by the double redistribution was offset. Skeletal reconstruction was necessary in eight cases with resultant good statics and stability in all. Bone surgery was omitted in three early cases; lateral stability and posture were found to be good in two and fair in one. Going back to the group of eight cases with apparently ideal results from posterior transposition of the tibialis anterior, it should be noted that in that series skeletal distortion had not developed, and no bone surgery was done.

Of the total forty-five cases of calcaneus imbalance in which transpositions of lateral muscles were done, adequate function was obtained in twenty-eight; improved function, in sixteen; and failure, in one. In consequence of these results, the author's present recommendations in calcaneus insufficiency are as follows: (1) In early cases without skeletal distortion, presenting weakness in the Achilles group only, do posterior transposition of the tibialis anterior without any bone surgery; (2) in early cases with complicating lateral imbalance, transpose the acting invertors or evertors, as the case may be; (3) in late cases with skeletal distortion but with muscle status as in (2), add necessary tarsal-joint resections; (4) in late cases with muscle status as in (1), combine tarsal reconstruction with posterior transposition of the peroneus longus and the tibi-

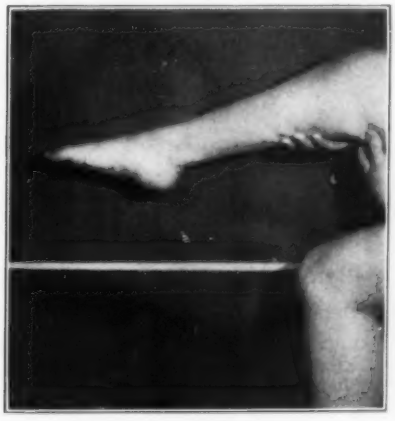

FIG. 8-A

FIG. 8-B

Fig. 8-A: Quadriceps paralysis, showing inability to extend knee against gravity.
Fig. 8-B: Capacity against resistance several years after transposition of biceps to patella.

alis posterior. This is quite feasible as a single operation, but the combination of tarsal reconstruction and posterior transposition of the tibialis anterior is more than should be attempted at one operation. Furthermore, while the tibialis anterior is the only strong leg muscle with a long-range action comparable to that of the triceps surae, extensive tarsal reconstruction is, the writer believes, certain to leave too much restriction of motion to permit tiptoe action even with muscle power adequate for it.

GROUP V—QUADRICEPS INSUFFICIENCY

There were found in this review eighteen cases of quadriceps insufficiency with hamstrings available for transposition. Except in cases of fixed knee-flexion deformity, quadriceps insufficiency is an example of straight static instability, and an exception to the general rule that this instability is not eradicable by tendon transposition alone. However, if transposition is done before adolescence, protection by brace against genu recurvatum may be necessary, according to hamstring status. In most of the cases of this series, simple forward transfer of the biceps was performed, but in a few with slightly subnormal biceps both inner and outer hamstrings were used. Of the eighteen cases, restoration of approximately normal control was secured in eleven and control adequate for stability in six; failure resulted in one.

MISCELLANEOUS TRANSPOSITIONS

Of the residual operations in the total reviewed, quite a few were in the upper extremity with transpositions at elbow and wrist, giving very satisfactory results, although not involving the special principles which this presentation was designed to emphasize. There remain a few cases of involvement of the lower extremity which may be mentioned briefly. Six patients received Legg's operation of transposition of the tensor fasciae femoris for gluteus-medius paralysis, with results inadequate to recommend the procedure particularly, and, to the author, illustrating the general rule of inapplicability of transposition of a dissimilar muscle in pure static imbalance. Yet, when this same muscle was utilized in the prime example of exception to this rule—that is, transposition of the tensor fasciae femoris to the patella for quadriceps insufficiency—in three out of six cases a functionally stable knee resulted. The three failures occurred where quadriceps paralysis was complete, while in the successful cases some quadriceps function (though inadequate) had remained. Still under observation are four other cases representing mainly static imbalance,—namely, isolated paralysis of the tibialis posterior, in which by the operative technique of von Baeyer the peroneus longus was transposed across the back of the ankle to the inner side of the foot. The result to date has been complete restoration of both function and statics, so that it may be a useful procedure for this probably rare residual imbalance.

SUMMARY AND CONCLUSIONS

About ten years ago, the writer arrived at a stage in the practice of surgical relief of paralytic residual imbalance in which the application of certain physical and kinetic principles seemed logically to point to fairly precise indications for selection and utilization of muscle and tendon transference in a given presenting situation of paralytic residuals. Since then, 300 operations have been performed with these principles in mind, and it has been possible to check up on the results three or more years after operation in 215 of these cases. The results have been analyzed according to function and statics, with conclusions and indications derived from the findings in five of the most common and sharply defined situations. Tendon transposition has proved to be a most useful procedure in restoration of lost function, and frequently an imperative procedure in the prevention and control of imbalance deformity. Its utilization diminishes the frequency and the extent of stiffening procedures, sometimes as an adjunct to them and sometimes as a preferable substitute for them. Its success is as much dependent on the meticulous evaluation of the presenting static, dynamic, and kinetic conditions as on the technique of the operative procedure.

SKELETAL TRACTION IN FRACTURES OF THE RADIUS AND THE ULNA

BY EUGENE L. JEWETT, M.D., ORLANDO, FLORIDA

The method of obtaining skeletal traction which the writer wishes to present is not new, but a few of its features have not been described before as far as he has been able to determine.

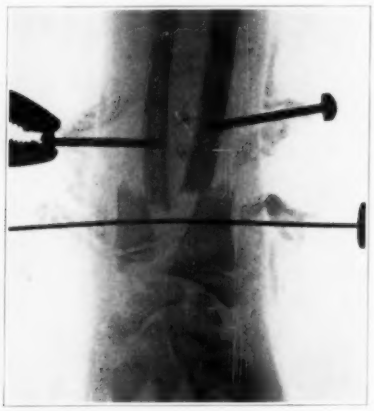

FIG. 1

Showing oblique displaced fracture of lower ends of left radius and ulna with Kirschner wire through the distal fragments and traction screws in the distal ends of the upper fragments. The Kirschner wire through the olecranon process is not shown.

A fifteen-year-old boy sustained a fracture of both bones of the left forearm a little above the wrist joint. His doctor made two unsuccessful attempts at closed reduction. The writer then tried reduction by the closed method. Felt pads were placed in the anterior and posterior interosseous spaces to separate the fragments, and molded plaster-of-Paris splints were carried from the fingers to the shoulder with the elbow at a right angle. Even though the fragments were in good position after reduction, they slipped by each other in a few days. Open operation was advised, but the family were very much opposed to it. Therefore, the following method was evolved, which proved to be highly successful.

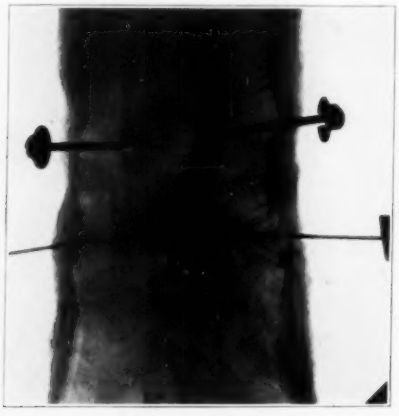

FIG. 2

Fragments in the adequately reduced position with the plaster-of-Paris cast applied and tongue-depressor strips holding the screw heads from the hardened plaster cast.

FIG. 3

Outer layer of plaster cast covering the screw heads and the Kirschner-wire retainers, thereby firmly anchoring all of the fragments in the plaster cast by means of skeletal fixation.

Under general anaesthesia, Kirschner wires were placed through the olecranon process and the lower radial and ulnar fragments. (See Figure 1.) The arm was suspended in a fracture frame. Then drill holes were made in the lower end of the upper fragments, as shown in the roentgenogram. Screws, made especially for this purpose, were inserted into the drill holes. Care was taken not to split the bone, but yet to obtain a sufficiently firm hold to give the desired traction. Then, by separating the two Kirschner wires, the desired extension was secured. When the fragments came into line, strong outward traction was applied on the two screws, which resulted in the reposition of the fragments into normal alignment. Repeated roentgenograms indicated when the reduction was satisfactory. A non-padded plaster-of-Paris cast was then applied from the fingers to the mid-arm, incorporating the wires and the screws. Pieces of tongue depressor were snugly placed between the hardened cast and the washers and heads of the screws, so as to prevent any recurrence of the displacement. (See Figure 2.) Plaster was then applied to cover the ends of the screws and the Kirschner-wire retainers (Fig. 3). The wires, of course, were not taken out of the fracture frame until the retainers were securely locked in the hardened plaster. Check-up roentgenograms showed good position of the fragments, and there was free motion of the fingers.

This plaster cast was cut down to the elbow at the end of eight weeks,

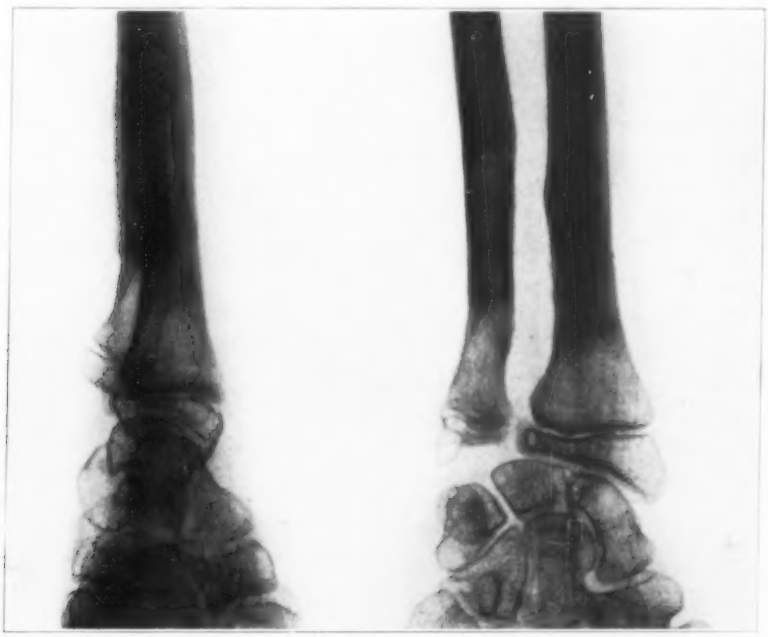

FIG. 4

Four and one-half months after reduction. Clinically and roentgenographically the results are excellent.

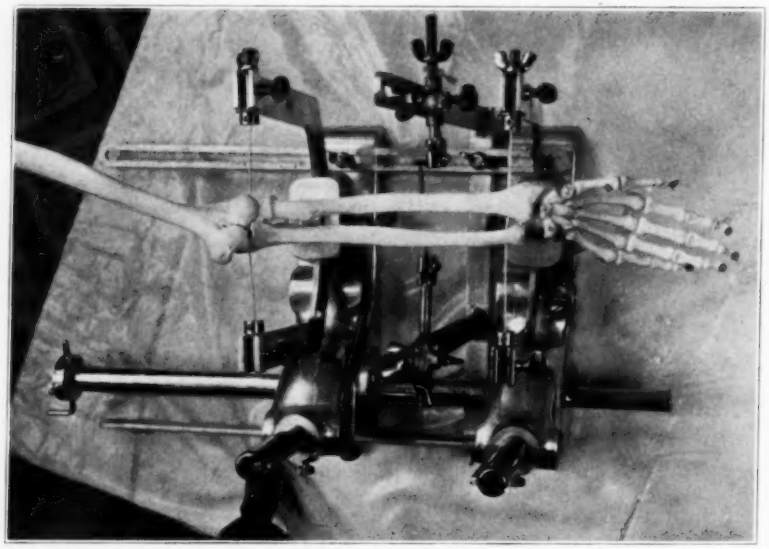

FIG. 5

Fracture frame with the author's screw-traction device attached.

so as to allow some motion at the joint; the olecranon wire was untouched. Roentgenograms taken at two-week intervals showed a rather slow formation of callus, but maintenance of the good position of the fragments. At the end of ten weeks the wires, screws, and cast were removed without any anaesthetic. A light anterior splint was worn for a few weeks more, just as a protection, and the patient was instructed to begin active motion of the involved parts. Four and one-half months after reduction he had normal use of all the joints of the left upper extremity. No deformity could be seen or felt. (See Figure 4.) The only signs of treatment were the small scars left by the wires and screws.

Figure 5 shows the additions to the fracture frame which the writer has made for handling such a case in the future. The adjustable screw-holding arms can be put into any position and they absolutely immobilize the fragments for the taking of roentgenograms and the application of the plaster cast. One of the troublesome features in the case described was the manual holding apart of the upper fragments.

The author feels that this method should be tried in all such cases which usually are subjected to operative means of reduction and retention.

OSTEOMYELITIS OF THE PATELLA

Report of Two Cases

BY R. J. DITTRICH, M.D., FORT SCOTT, KANSAS

From the Orthopaedic Service of Mercy Hospital

Primary hematogenous osteomyelitis of the patella is such an uncommon affection that our knowledge of it is gained almost entirely from the study of single cases. In many instances the diagnosis of this condition is not clear until a septic arthritis of the knee joint has occurred by extension of the destructive process. In the majority of cases the course of the infection is acute, and the involvement is so extensive that all or most of the patella is extruded in the form of sequestra.

Case 1. L. D., white male, aged twelve years, was seen on January 15, 1935. In December 1933 he had injured the left knee when he stepped into a hole in a porch. There was no abrasion of the skin, but considerable pain and mild swelling were noted in the anterior portion of the knee. A splint was applied by the family physician. After several weeks this was removed, and the knee was swollen, painful, and tender. The condition improved gradually but always remained somewhat painful, especially on walking. A few weeks before examination the pain became more severe and a decided limp developed.

Examination of the knee showed a moderate swelling over and around the patella with a mild degree of tenderness, most marked over the patella but involving also the joint line anteromedially and anterolaterally. There was a mild effusion into the joint. Motion was practically complete and produced very little pain.

The patient was admitted to the hospital two weeks later. At this time there was an increase in the swelling and heat over the patellar region. Motion was free but painful on extreme flexion. No abnormal mobility was noted. There was definite tenderness over the patella, mostly in the lateral and superior portions. The patella was freely movable. Mild tenderness was present along the upper margin of the tibia anteromedially. The effusion in the joint had increased somewhat since the the first examination, but was entirely painless. Except for hypertrophied and chronically infected tonsils, the patient had no other abnormalities.

Urine examination showed nothing abnormal. The leukocyte count was 12,000.

Roentgenographic examination (Fig. 1) showed an irregularity of the contour of the lateral and superior borders of the patella, atrophy and cavitation of the anterior two-thirds, and a proliferative periostitis of the anterior surface.

A diagnosis of osteomyelitis was made, and an operation was performed on February 9, 1935. A median longitudinal incision was made; the periosteum was reflected; and, with mallet and osteotome, the anterior portion of the patella was removed down to the cavities, one in the medial and one in the lateral portions of the bone. The cavities were from five to seven millimeters in diameter and contained soft, grayish degenerated tissue, mucopurulent in character. This material was removed with a curette. Due to the low virulence of the infection, it was decided to do a primary closure of the wound.

Bacteriological examination showed a profuse growth of staphylococcus aureus.

The report of the pathological findings by Dr. C. A. Hellwig follows: "Grossly the bone appears partly necrotic and hemorrhagic. Micropscopically, the cartilage shows deep fissures at the surface and the matrix shows degeneration. Most of the bone trabeculae have well-stained bone cells. There are a few spicules without definite nuclear

FIG. 1

Case 1. Roentgenogram of patella before operation, showing cavities in both the medial and the lateral portions.

FIG. 2

Case 1. Roentgenogram taken two years after operation, showing regeneration of bone.

stain. There are also small areas where new bone trabeculae are found. The bone tissue is replaced in many areas by fibrous tissue which is cellular and infiltrated with plasma cells and a few leukocytes. No definite abscesses are found. Pathological diagnosis: Subacute osteomyelitis."

Following operation the patient's temperature continued a septic course (98.6 to 102.6). Considerable swelling appeared along the incision, and small amounts of pus were discharged, necessitating removal of the sutures. In addition, the knee joint was distended gradually by effusion which was painless and evidently aseptic.

On February 27, 1935, the joint was aspirated and seventy cubic centimeters of clear greenish fluid were withdrawn. Roentgenographic study on the same day showed that a portion of the patella involved in the destructive process was still present, and this, together with the other findings of a progressive condition, indicated that further operative measures were necessary.

The next day the wound was opened down to the bone. The anterior surface of the bone consisted of soft friable bone and granulation tissue. In removing the affected portions of bone along the lateral border of the patella, an opening was accidentally made into the joint, allowing about twenty cubic centimeters of greenish fluid to escape into the wound. The wound was packed lightly with vaselin gauze.

Following this procedure, the temperature rose to 100.2 degrees on the second and third days, and then returned to normal. The amount of drainage decreased from day to day. On March 16, 1935, the vaselin gauze was removed. After ten days the drainage ceased, there was no tenderness or effusion of the joint, and motion was possible from 90 to 180 degrees. The patient had a complete return of function which was in all respects normal. A roentgenogram (Fig. 2), taken in April 1937, showed a satisfactory regeneration of the patella.

CASE 2. R. C., white male, aged fifteen years, was seen on May 7, 1937. During the previous six months he had had occasional mild pain in the right knee. This was never severe enough to incapacitate him for ordinary activity, although the knee was quite painful whenever it was injured. Disability was most prominent during gymnastic exercises at school. He could recall a number of injuries to his knee, although there had never been any abrasion of the skin or any swelling of the joint.

FIG. 3-A

FIG. 3-B

Case 2. Roentgenograms showing small area of destruction on posterior surface of patella.

The patient had complete range of motion in flexion and extension. There was no disturbance of gait, no swelling, and no effusion. Mild tenderness over a small area medial to the patella constituted the only positive finding.

Roentgenographic study (Figs. 3-A and 3-B) showed a small cavity on the posterior aspect of the patella. This was oval in shape and surrounded by a layer of condensed bone.

A diagnosis of osteomyelitis was made. From the clinical course it appeared that this was at the time a benign process, although potentially dangerous. For that reason it was considered advisable to remove the focus.

FIG. 4

Case 2. Roentgenogram taken ten weeks after operation, showing healing of bone.

Operation was undertaken on May 14, 1937. After the anterior surface of the patella had been exposed, a drill hole was made anteriorly. This was enlarged with a burr. After the desired depth had been reached, the cavity was located with a small drill. The contents of the cavity consisted of dense fibrous tissue and soft granulation tissue. No pus was found. The margins of the cavity were removed with a curette. The wound was packed lightly with vaselin gauze.

Bacteriological examination showed no culture.

The report of the pathological findings by Dr. C. A. Hellwig read as follows: "There are fragments of bone with hemorrhagic and inflammatory changes. In one area there is noticed a necrosis of bone spicules surrounded by leukocytic infiltration of the bone marrow. Diagnosis: Osteomyelitis."

Following operation there was a moderate amount of drainage, which decreased from day to day. After two weeks the drain was removed. Three weeks later the wound was healed. At the time when this report was written, the patient had been ambulant

for five weeks, without any return of symptoms. There was no swelling, tenderness, or restriction of motion.

Roentgenographic examination (Fig. 4), on July 26, 1937, showed practically a complete regeneration of the bone with no evidence of destructive process.

DISCUSSION

In both of the cases reported the symptoms had been of long duration. They were mild in character; in fact, they were so inconspicuous that one would hardly suspect the true nature of the disease. From the roentgenographic appearance, it is also evident that the destructive process had been of long duration. It is possible that in some of the cases with an acute course a chronic infection has been present for some time previous to the acute onset. This is especially to be suspected in those cases in which complete sequestration of the bone occurs early in the course of the disease.

It is to be expected that a chronic focus of destruction, which is well defined in the roentgenogram, even though it is mild symptomatically, will not indefinitely continue a benign course but will eventually become active. With this in mind, it is considered advisable, when the diagnosis is clear, to eliminate the destructive process while it is still in the chronic stage.

FRICTION VERSUS TRACTION

A Simple Appliance for Use in Making Traction to the Head

BY ALBERT H. FREIBERG, M.D., CINCINNATI, OHIO

From the Department of Orthopaedic Surgery, University of Cincinnati Medical School

Maximum efficiency in applying traction to the head or to the extremities is to be attained only by eliminating as far as possible the element of friction. By this is meant not simply friction in the mechanism itself, but, what is much more important, friction between the head or extremity and the surface of the bed upon which it rests. Failure to recognize this fact and to make provision for it has resulted only too often in dissatisfaction with the method or in the unnecessary and undesirable elaboration of apparatus and even of the plan of treatment.

The author has long held the opinion, as the result of experience, that the sole virtue of the Russell (so-called "Australian") method of traction to the lower extremity lies in holding the extremity suspended, so that friction is thereby rendered inoperative. This can be demonstrated by suspending the extremity in a sling from an overhead frame and by making traction at any desirable angle in the ordinary manner. The limb swings comfortably like a pendulum, and friction against the bed surface is completely eliminated. The weight of a leg in a number of adult males has been ascertained by means of an accurate spring balance, and it has been found to vary between fifteen and eighteen pounds. It follows that in practice this much weight must be used merely to overcome the friction factor before the tractive effect becomes evident at the desired point on the limb. This amount of weight is not only superfluous, but, when adhesive plaster is used, it causes the plaster to slip and to irritate the skin unnecessarily. While this method cannot compete in mechanical efficiency with traction upon bone by the insertion of metal pins, skeletal traction constitutes a complication which is frequently both undesirable and unnecessary, especially when hospital care is not feasible. However, even when skeletal traction is employed, that amount of force which must be used merely to overcome friction is wasted and undesirable if it can be shunted out altogether.

The heads of fifteen recumbent male patients and of an equal number of recumbent female patients were weighed with the spring balance by Dr. William A. Bishop, Jr., the Orthopaedic Resident at the Cincinnati General Hospital. While there was some variation in weight according to size, the average weight was eight and one-half pounds. The heads of a number of children below the age of twelve were weighed in the same manner. The average weight of the head in patients between the ages of five and twelve was six and one-half pounds, although the variation was

greater than in adults. If the weight of the head rests upon bed and pillow, as has been the usual practice in the past, a corresponding amount of force must be applied to the head merely to overcome friction and before the cervical spine is subjected to the tractive effect in any adequate degree. This is true even with the insertion of pins into the skull for skeletal traction, and the use of this much force merely to suspend the head fulfills no other useful purpose. In the case of traction to the head for lesions of the cervical segment of the spine, however, it has been found that great force is seldom, if ever, necessary provided always that the force is efficiently applied.

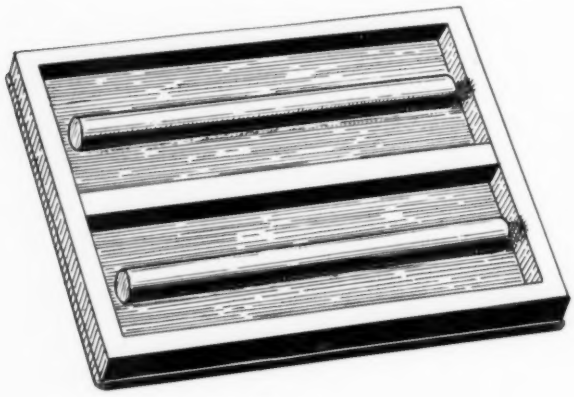

FIG. 1

The tray, containing the two dowel cylinders, as seen from above.

The simple appliance which is shown in Figures 1 and 2 is offered as a means of reducing friction to a minimum. It can be easily and rapidly improvised in any ordinary shop, since it requires only such materials as are everywhere obtainable. The author has used it with great satisfaction for several years.

The appliance (Fig. 1) consists of four separate pieces made of wood:

1. A tray, eight by ten inches, made of thin wood; so-called "plywood" is preferable, but not indispensable. To the four sides of its upper surface is fastened a rim of wooden strips, one-half an inch in height and in width, and the tray is divided into two equal compartments by another strip, of the same dimensions, placed transversely.

2. Two dowel pins (wooden cylinders) cut to such a length that they will roll easily in each compartment. Each pin should be five-eighths of an inch in diameter, so that it projects slightly above the height of the rim of the tray.

3. A top of plywood or other thin wood, ten by ten inches, on which the head is to rest. To the upper surface of this there may be glued a pad of sponge rubber, a so-called kneeling pad such as may usually be found in the "five-and-ten-cent" store. This pad is not indispensable, but it adds much to the patient's comfort as well as to the efficiency of the apparatus.

When the top is placed upon the rollers, it will move to and fro with friction reduced to a minimum, because the rollers are somewhat higher than the rim of the tray. In use, the appliance is placed under the patient's head with its upper end slightly higher than the lower, so that

the rollers will tend to move toward the lower or foot end by gravity. The head should rest upon a thin pillow of about the same size as the top board. (See Figure 2.) Like every other similar appliance, it requires occasional inspection during use in order that it may be kept continuously effective. The rollers must be prevented from impinging upon their upper barriers and this will be apparent even to an untrained person.

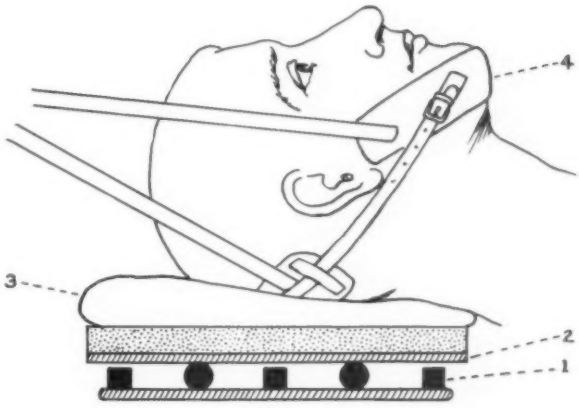

FIG. 2

Vertical section of the apparatus in use: *1*, the tray; *2*, the top resting upon the rollers and covered with layer of sponge rubber; *3*, small pillow of the same size as the top; *4*, the halter, which should impinge upon the chin and not upon the neck.

Experience with this appliance has shown two factors of no little importance. Since it is not necessary to employ about eight pounds of force to the heads of adults and correspondingly less in children, merely to overcome friction, the problem of a comfortable halter has become greatly simplified, even to the point of being non-existent. As a matter of fact, this involves the second factor,—we have found it unnecessary to use as much weight for effective traction as we were compelled to employ, by the old method, to overcome friction alone. Under continuously effective traction, not nearly as much weight is required as we had before thought necessary. The weight which we have employed with this apparatus has varied between three and six pounds. This much weight is easily tolerated even with a halter improvised out of muslin bandage. It has also been found practical to make the head halter out of washable material.

The appliance described has been used both for children and for adults, and for traumatic conditions as well as for disease of the cervical spine. It has given satisfaction in the hands of others, as well as in those of the author. It is applicable not only in hospital practice, but also under quite adverse circumstances.

The author is indebted to Mr. Joseph Homan of the Department of Medical Art for his kindness in furnishing the illustrations.

A CASE OF PRIMARY BACILLUS-PYOCYANEUS ARTHRITIS IN AN INFANT

BY W. A. BISHOP, JR., M.D., CINCINNATI, OHIO

From the Department of Orthopaedic Surgery, University of Cincinnati Medical School

Primary systemic infection by the bacillus pyocyaneus is sufficiently infrequent to merit discussion. This organism is usually considered as having a low pathogenicity, manifesting its presence occasionally as a secondary invader in localized pyogenic processes. It is found as a secondary invader in such conditions as furuncles, infected wounds, etc., most frequently being considered a nonpathogenic parasite.

The bacillus pyocyaneus was first obtained by Gessard, in 1882, in pure culture from two cases of skin wounds showing bluish-green discoloration. Not long thereafter, the organism was found by numerous investigators in colored suppurations in various portions of the body. By 1897, the organism had been repeatedly found not only in open wounds, but also in generalized infections with severe constitutional symptoms, as reported by Baker.

In a review of the literature in 1906, Rolly collected a series of cases of infections of internal organs in which the bacillus pyocyaneus was either the sole or an associated invader. In this list were such diseases as perityphlitis, pyelonephritis, mastitis, and panophthalmitis; a case of prepatellar bursitis; and cases in which fistulae were present.

In a study of 12,000 autopsies, Fraenkel concluded that the bacillus pyocyaneus was the principal invader in only thirteen cases. In 1917, he presented a study of twenty-six cases of primary pyocyaneus invasion in which there were twenty-one children under two years of age and five adults. He observed cases of otitis, enteritis, ecthyma gangraenosum, endocarditis, meningitis, sepsis, and others, due directly to infection with this organism. He concluded that it may act not only locally with the production of toxin, but also through the actual invasion of internal organs; and he expressed the belief that, although this organism was rarely the primary cause of disease, nevertheless, the majority of such pyocyaneus infections were acute and fatal almost without exception. The later articles concerning bacillus-pyocyaneus infection in man add nothing to this classical description.

Although many instances of infection have been reported in which the bacillus pyocyaneus was the principal invading organism, a search of the literature revealed but one reference to primary joint involvement. This case was reported by Pinelli and was that of an eight-month-old infant with arthritis of the left shoulder from which was isolated a pure culture of the bacillus pyocyaneus. The patient was treated with autogenous vaccine, and was discharged from the hospital two weeks after

admission as having satisfactorily recovered. The use of autogenous vaccine in the treatment of systemic diseases of bacillus-pyocyaneus etiology was reported by Wassermann as early as 1896 and is still accepted as the most advantageous attack on the inroads of pyocyaneus infection in internal organs and in concealed tissue spaces.

CASE REPORT

R. B., a well-developed and well-nourished white male, aged three and one-half years, was admitted to the Orthopaedic Service of the Cincinnati General Hospital on February 2, 1937, with a swollen and painful right ankle.

Fifteen months previously, on November 11, 1935, he had been admitted to the Dermatological Service with first and second degree burns involving about one-fourth of the body surface, including the right leg and foot. By the fourth hospital day, there had developed a rather severe pyodermia of the involved area with evidence of bacillus-pyocyaneous infection. Three weeks after entry, multiple subcutaneous abscesses had appeared, including one over the insertion of the Achilles tendon on the right. Roentgenograms of the right ankle were negative. A culture of the pus obtained at the time of incision and drainage showed, among other organisms, bacillus pyocyaneus. The temperature curve rose again ten days later, at which time repeated roentgenograms showed beginning destruction of the lower tibial epiphysis on the right. An incision and drainage of the ankle was done at that time, but, unfortunately, the pus was not cultured. The patient was discharged from the hospital on the 114th day after entry, March 3, 1936, as having recovered sufficiently to walk unassisted. He was to be followed in the Out-Patient Department, but he did not return.

On readmission, his mother gave a history of his having had pain in the right ankle and a limp of about one week's duration. Three days before admission, redness and swelling of the joint had developed; this was associated with an elevation of temperature and night sweats. The mother stated that for several weeks after leaving the hospital fifteen months previously, the patient had walked with a limp, but that this had completely disappeared and for the past year he had had no complaints.

Examination at the time of his second admission revealed a well-developed and well-nourished white male infant who was obviously acutely ill, but only moderately toxic. There was swelling of the right ankle with redness of the overlying skin and increased local heat. Fluctuation was present below and anterior to both malleoli. Saphenous and femoral lymphadenopathy was quite obvious on the right side.

Incision and drainage of the right ankle joint was done under strict aseptic technique, and yielded a small amount of thick bluish-green pus. On smear and culture, only S-shaped rods of bacillus pyocyaneus were found. An autogenous vaccine was made, small doses of which were given intradermally on alternate days.

The cast was changed on the thirtieth day after admission, at which time the wound was well healed, and there was but little tenderness. The patient was discharged to the Out-Patient Department where vaccine therapy was continued for one month.

SUMMARY

In this case, the bacillus-pyocyaneus infection developed in an area of first and second degree burn of the leg. Subsequently, the infection involved the soft tissues about the ankle joint, followed by roentgenographic evidence of destruction of the distal tibial epiphysis on the right. Fifteen months after recovery, a pyarthrosis of the same ankle developed, from which a pure culture of bacillus pyocyaneus was obtained. Recovery ensued after incision and drainage of the ankle and autogenous-vaccine therapy.

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A SPECIAL BONE RETRACTOR FOR SUBTALAR ARTHRODESIS

BY WILLIAM H. VON LACKUM, M.D., F.A.C.S., NEW YORK, N. Y.

From the New York Orthopaedic Dispensary and Hospital

The technical difficulties frequently encountered in obtaining satisfactory exposure and visualization of the talocalcaneal joint in doing a subtalar arthrodesis have led to an effort to simplify this step in the procedure.

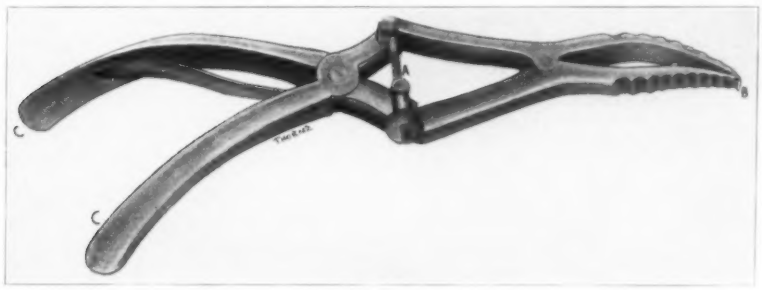

FIG. 1

Bone retractor, improvised from a Hamilton-Cook uterine dilator, for use in subtalar arthrodesis:
A: Adjustable lock screw.
B: Steel pegs.
C: Handles rotated 180 degrees.

For this purpose, a Hamilton-Cook uterine dilator has been converted into a partially self-retaining retractor, as seen in Figure 1, by rotating the handles 180 degrees, and by applying an adjustable retaining screw and bolt to the handle, and sharp steel pegs to the tips of the blades. When in position, as shown in Figure 2, the instrument opens widely this hitherto relatively inaccessible talocalcaneal joint, so that the joint surfaces may be well visualized, thus greatly facilitating the clean excision and reshaping of the joint surfaces.

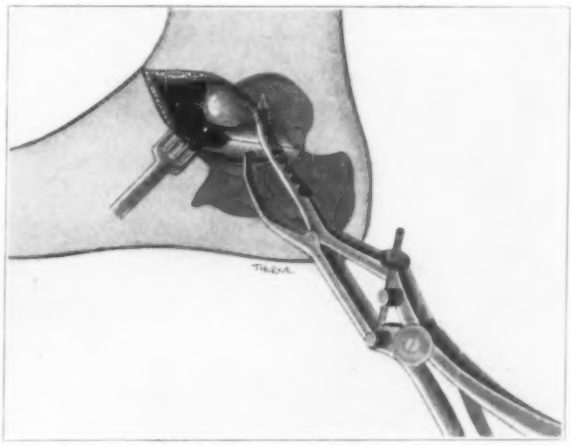

FIG. 2

Retractor in place, showing the talus and os calcis wedged apart laterally. The articular surfaces are thus made accessible for excision.

This instrument is particularly helpful in performing arthrodeses on immobile, arthritic, or post-traumatic feet, in which the talocalcaneal joint is involved. It has also been used to advantage in exposing the articular surfaces in fusion of the ankle joint.

A NEW KNIFE FOR USE IN REMOVING SEMILUNAR CARTILAGES

BY FRANK A. LOWE, M.D., SAN FRANCISCO, CALIFORNIA, AND LOUIS W. BRECK, M.D., EL PASO, TEXAS

In spite of the fact that the removal of a semilunar cartilage is a relatively common procedure for the orthopaedic surgeon, it is still a rather difficult one for many men, and occasionally even for the most dexterous. The hardest part of the procedure is the freeing of the cartilage from its attachment. Due to the fact that the condyles of the femur are in close apposition to the upper end of the tibia, there is very little space in which to work, even if a large incision has been used. With a small incision, it is perhaps even more difficult. The most common method of freeing the cartilage is by means of a pair of scissors, and usually it is somewhat hard to insert them along the lateral and posterolateral attachments of the cartilage and to bring them into play. The surgeon is often forced to make numerous attempts, and, when he has finished, an

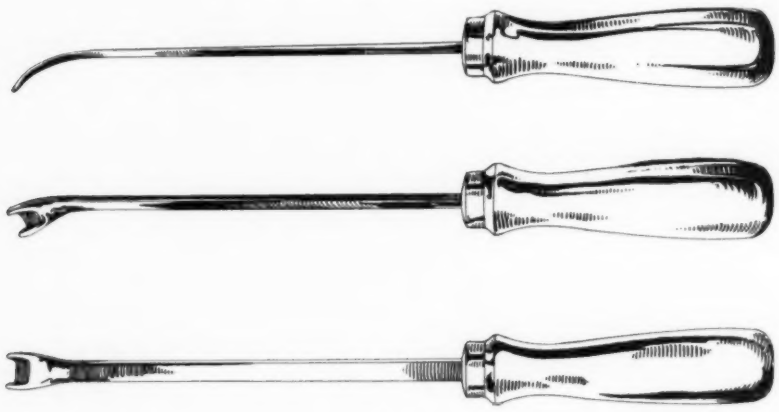

FIG. 1
Showing the construction of the cartilage knife.

irregular or serrated border of the cartilage is left and the removal is accompanied by more trauma than is desirable.

We have designed a knife to be used in removing semilunar cartilages which we have called the Lowe-Breck cartilage knife, and we believe it to be quite an addition to the armamentarium used in this procedure. It is essentially an end-cutting knife with small guides on the sides of the blade, and the end of the knife is curved to conform to the contour of the semilunar cartilage. Other end-cutting knives have been devised for this purpose, but we have been unable to find any knife similar to the one we are describing.

Figure 1 shows the general construction of the knife which consists of a handle, a shaft, and a curved end, on the tip of which is a knife edge with a small guide on either side. The shaft and end together measure six inches, so that the instrument is fairly long. The curve involving the terminal one and one-fourth inches permits the blade to follow the border of the cartilage, for its contour corresponds to that of the meniscus. Inasmuch as the contours of the medial and lateral menisci are almost the same, and since the instrument is symmetrical, it can be used as well for one cartilage as for the other. The end-cutting blade is effective and at the same time not dangerous, for the guides on each side prevent it from invading the tissues. The guides themselves are blunt and are not dangerous if handled with ordinary care.

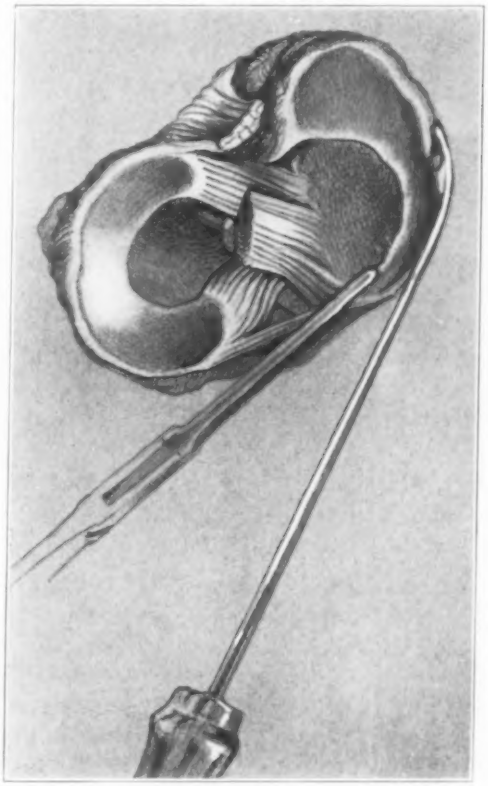

FIG. 2

Diagrammatic drawing showing the top of the tibia with the cartilage knife in place and the meniscus half removed.

If this knife is used, the operator may choose the incision which he has found most successful. The semilunar cartilage which is to be removed is identified, and its front end is grasped with a strong clamp and freed with scissors for a distance of one-half to one inch. The cartilage knife is then placed along the attachment of the meniscus at the end of the scissors cut. The knife is adjusted so that its curve is accommodated to the contour of the cartilage. Pressure is then exerted on the knife and, as it cuts, the attachment is followed around until the cartilage is free. Once the knife is placed properly and the cutting has been begun, it is usually quite easy to follow the border of the meniscus, for the cartilage cuts fairly easily and the guides on the knife hold it in place and prevent it from slipping. Figure 2 illustrates the manner in which the instrument is used and shows how the curve on the end of the knife fits the contour of the cartilage.

We have found the instrument very useful in a procedure which is not always easy, and we hope that others may find it equally valuable.

PERONEAL-NERVE PALSY DUE TO COMPRESSION BY ADHESIVE PLASTER

BY SETH SELIG, M.D., NEW YORK, N. Y.

Adhesive traction as described by Russell[1] has become increasingly popular as a method of treating fractures of the shaft of the femur. While the physics of this method has been thoroughly described, little attention has been given to the technique of applying the adhesive to the leg. In any method in which traction is used, constant vigilance and frequent adjustments are necessary to maintain the efficiency of the method and to avoid complications.

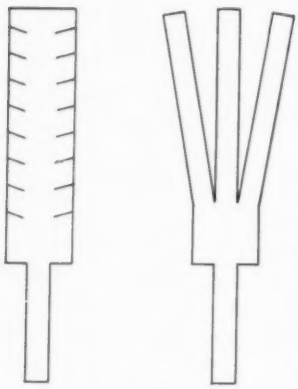

FIG. 1

The two most common methods of applying adhesive traction strips to the lower extremity. Anchoring strips, whether transverse or oblique, are not shown in this illustration and may be dispensed with.

Recently five cases of pressure neuritis of the common peroneal nerve, caused by improperly applied adhesive plaster, have come to the writer's attention.

In two of the cases the adhesive had been applied for the purpose of making traction according to the method of Russell. One patient was a woman, seventy-nine years old, with an intracapsular fracture of the neck of the femur fixed by a metal screw, and Russell traction had been applied as an added safeguard. At the time of her death from an infected decubitus ulcer, six weeks after the peroneal palsy had been noticed, there was no improvement in the neurological condition. The second case of peroneal palsy occurred in a nine-year-old boy suffering from a hemolytic-streptococcus infection of one hip which was treated in Russell traction. The nerve symptoms disappeared in six months. Both patients had complained of pain in the foot and along the anterior aspect of the leg for from one to seven days before paralysis appeared, and the pain was erroneously ascribed to the hip. The neuritis was due to direct pressure by a transverse strip of adhesive used as an anchor for the longitudinal strips, crossing the upper end of the fibula and compressing the common peroneal nerve against the bone.

In two cases the peroneal-nerve palsy followed continuous intravenous injection into one of the leg veins as a postoperative therapeutic measure. The neuritis in these cases was also caused by pressure of one of the transverse adhesive strips with which the extremity had been strapped to an immobilizing board.

A fifth case of common peroneal-nerve palsy occurred after arthrot-

omy of the knee joint for removal of a torn internal semilunar cartilage. The dressing was held in place by two strips of half-inch adhesive that encircled the extremity; the lower strip crossed the upper end of the fibula and compressed the common peroneal nerve.

While there are many methods of applying adhesive traction, the two most common ones are illustrated in Figure 1. In both methods it is customary to apply oblique or transverse adhesive strips to anchor the longitudinal ones. Over all of these strips a bandage, preferably of the elastic type, should be applied. Care must be taken to avoid placing

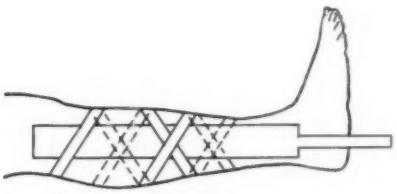

FIG. 2-A

Improperly applied traction. The oblique anchoring strips cross the fibula near its upper end where there is danger of injuring the common peroneal nerve.

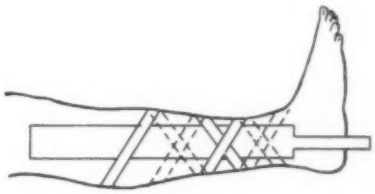

FIG. 2-B

Properly applied adhesive in which no transverse strips cross the upper three inches of the fibula. The transverse strips may be dispensed with.

either the transverse or the oblique strips across the upper three inches of the fibula, because it is at this point that the peroneal nerve is superficial and readily compressed against the underlying bone. (See Figures 2-A and 2-B.)

Care must also be used in applying the distal, transverse, or oblique turns of adhesive which pass over the anterior aspect of the ankle joint. If these have been applied too tightly or too near the dorsum of the foot, the inevitable slipping of the side strips causes them to cut into the soft parts.

Any complaint of pain in the leg or foot in a patient with adhesive traction or dressings about the knee joint should be carefully investigated. This also applies to cases in which the limb has been immobilized in a plaster bandage, as we are all familiar with common peroneal-nerve palsy due to pressure of a plaster bandage over the upper end of the fibula.

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AN ADAPTATION OF THE BALKAN FRAME FOR DEVELOPING MOTION AND ABDUCTION OF THE HIP

BY PAUL L. NORTON, M.D., AND FRED ILFELD, M.D., BOSTON, MASSACHUSETTS

From the Orthopaedic Service of the Massachusetts General Hospital, Boston

The traction-suspension apparatus described here was evolved primarily to meet the need of early mobilization of the hip joint following surgery, particularly acetabuloplasties and arthroplasties.[2]

In these particular operations, early motion in flexion and abduction is essential to a successful result. The ordinary traction-suspension de-

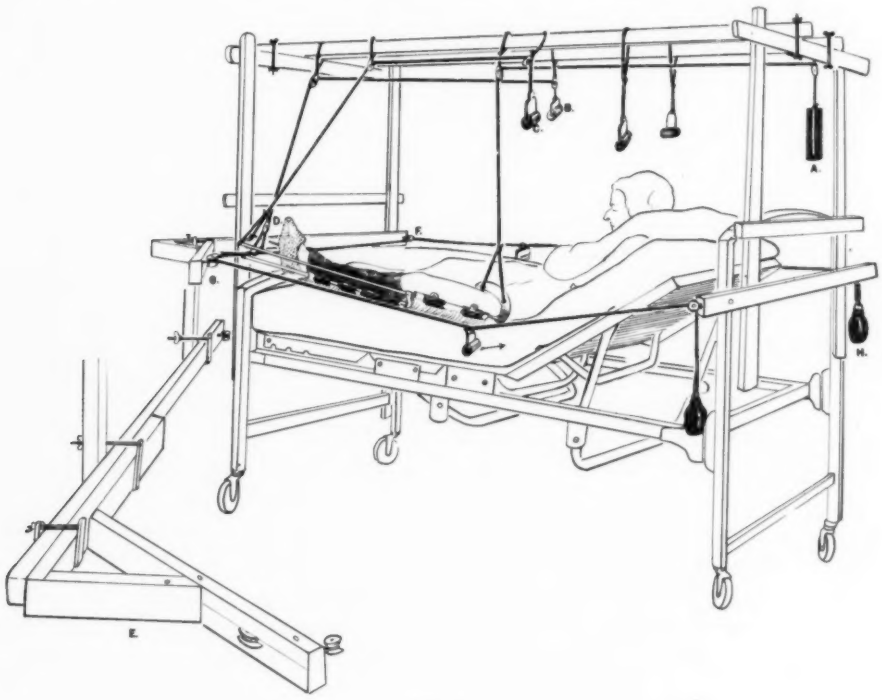

FIG. 1

vice allows adequate flexion of the hip, but does not permit enough abduction. With a Balkan frame as the foundation, the ordinary type of traction-suspension has been modified to allow wide abduction. The apparatus has been used in over forty-five cases of hip-joint surgery, but its use need not be restricted to that particular joint.

Passive hip motion in flexion and abduction is started in traction-suspension on the third or fourth day postoperatively, and usually by the end of the first week the patient is encouraged to try active move-

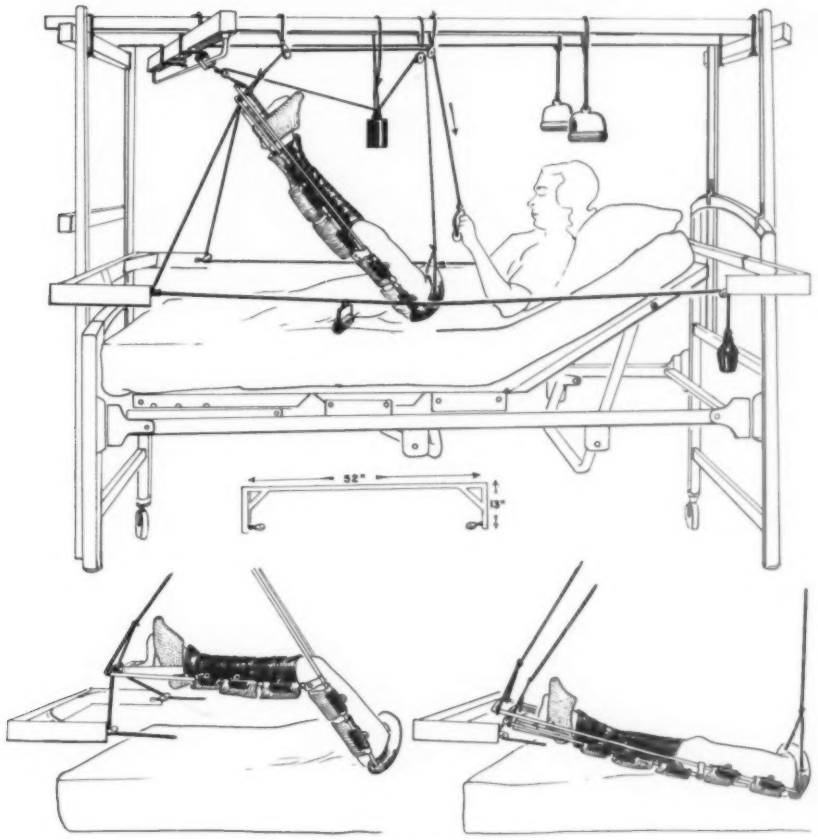

FIG. 2

ments. The motions of abduction, flexion, and knee extension are stressed. At the end of two or three weeks the apparatus is removed and the patient is allowed up in a walker for one week and is discharged walking with crutches.

Figures 1 and 2 illustrate two types of traction-suspension both hung from the standard Balkan frame. Any hospital treating fractures or special orthopaedic cases will have the necessary articles for setting up this device.

After moleskin adhesive has been applied to the lower leg, a Hodgen splint with a Pierson attachment is fitted to the extremity. Traction is maintained by a piece of tourniquet rubber tubing tied to the end of the Pierson attachment and fixed to a footpiece (omitted in the drawing). A three-pound weight, hung over the end of the bed on a swivel pulley, may also be used. If heavier traction is indicated, a Thomas ring splint should be used in place of the Hodgen splint.

The ring end of the splint is held in place by a ten-pound weight (*A*) and the distal ends of the Pierson attachment and the splint are controlled by ropes leading to the handles (*B* and *C*).

A pulley (*D*) is placed on the rope fastened to the lower end of the Pierson attachment. This pulley allows greater lateral motion and keeps the splint from rotating.

A Russell-traction endpiece is fastened onto a crossbar as shown in the insert *E*. Ropes then run from each side of the Pierson attachment through the lateral pulleys (*F* and *G*) to a crossbar at the head of the bed where they attach to three-pound weights (*H*) pulling through a second set of pulleys.

Handles are placed on these lateral ropes so that by pulling on them the patient may abduct or adduct the leg.

Traction on *B* flexes the hip with the knee extended. Traction on *C* flexes the hip and the knee. The hip may be flexed by pulling on *C* while the knee is passively flexed and extended by means of alternating traction on *B*.

The type of apparatus in Figure 2 may be arranged more quickly and allows easier lateral motion. The leg is placed in a Hodgen splint in traction and balanced with a five-pound weight. The assembly is suspended from a standard Balkan frame. The distal end of the splint is attached to a pulley which moves on a steel bar *; this allows wide abduction. The lateral ropes are run through pulleys on a special crosspiece as shown in the drawing. Flexion and extension of the knee are illustrated in the lower diagrams. Abduction of the hip is routinely performed in varying degrees of flexion.

* The bar is made of one-half inch cold rolled steel and is bolted to a piece of joist four feet long and one inch by one and three-quarter inches in cross-section. The distance between the joist and the rod is two and one-half inches.

REFERENCES

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2. Smith-Petersen, M. N.: Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum, and Coxa Plana by Means of Acetabuloplasty. J. Bone and Joint Surg., XVIII, 869, Oct. 1936.

A TRACTION APPARATUS FOR FRACTURES OF BOTH BONES OF THE FOREARM

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

The apparatus shown in Figure 1 was developed to overcome the awkwardness of the Soutter reduction apparatus when applied to forearm fractures.

CONSTRUCTION

The bases which screw on the table are made of boiler plate, folded to form a channel; one side of each base is drilled and threaded for thumb screws. The uprights are made of flat crucible steel, 12 or 14 gage, bent to shape and riveted into the bases. The screws are threaded steel rods which run through a short piece of Shelby tubing that projects far enough to form a shoulder against which the winged nut bears. On one side, the screw of an ordinary C clamp, four or five inches in length, is used because the pitch of the thread is steep and the screw is, therefore, rapid

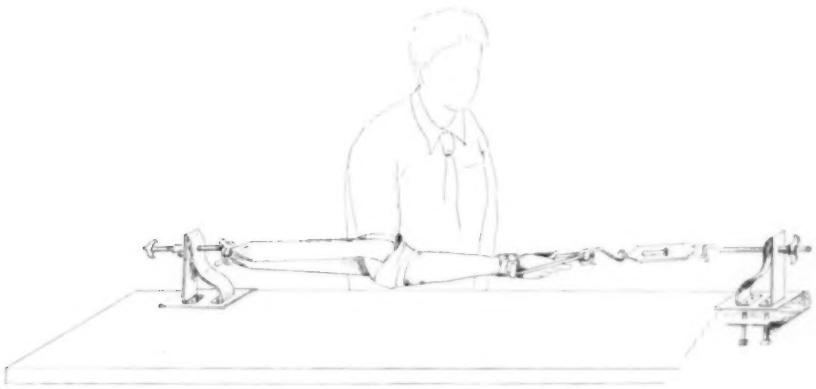

FIG. 1

in action. The end of the C clamp which carries the screw is sawed off with a hack saw, drilled, threaded, and mounted on the upright with machine screws. The swivel cap which is standard on the end of the C-clamp screw is drilled and threaded, and a crosspiece is fastened to it with machine screws to give attachment to the rings at the ends of the cuff straps. The wrist cuff is made of soft leather, it encircles the wrist twice, and it is fastened with a buckle. At the elbow, soft webbing is applied in the figure-of-eight manner.

TECHNIQUE

By means of this apparatus, graduated traction is applied for regular periods of time with a relaxation interval of two or three minutes every

five minutes. Fifteen pounds of traction is used at first and this is increased by five pounds at each period, as recommended by Dr. Soutter. After twenty to thirty minutes, muscle relaxation is usually complete, and there is an interval of six or eight minutes during which the fragments can be manipulated into position.

After the position of the fragments has been checked with the fluoroscope or roentgenograms and found satisfactory, a circular cast is applied from the elbow cuff to the wrist cuff. This is carefully molded over the dorsal and ventral interosseous spaces in an attempt to maintain separation of the radius and the ulna. When this part of the cast has thoroughly set, the traction is released, the cuffs are removed, and the plaster is continued up over the elbow to the middle of the upper arm, and down over the wrist to the heads of the metacarpals.

ADVANTAGES

The apparatus can be attached to any table in a few moments by four thumb screws. Since it is fixed to a table, it is steady. It holds the arm up from the table, permitting the taking of roentgenograms or the use of the fluoroscope and the application of a plaster cast over the greater part of the forearm, while maintaining traction. Detached from the table, it weighs only a few pounds and can be packed in a small box.

NEW TECHNIQUE IN THE TREATMENT OF FRACTURES OF THE FOREARM *

BY LELIO ZENO, M.D., ROSARIO, ARGENTINE REPUBLIC

Fractures of the forearm, Colles' fracture, and fractures of the diaphysis of either radius or ulna, or of both bones, may be reduced by traction on the hand with flexion of the elbow to a right angle, allowing countertraction of the arm. One or more assistants are needed, and the surgeon cannot always be sure that proper traction and countertraction are maintaining the fragments in a satisfactory position while the plaster-of-Paris bandage is being applied. Sokolowsky of Warsaw has devised an apparatus which simplifies this procedure. (See Figures 1-A and 1-B.) Reduction of the fracture fragments in the corrected position is maintained and, at the same time, the bandage can be applied with ease. The apparatus may also be used for fractures of both bones when the direct open operative method has been undertaken to obtain a more effective reduction.

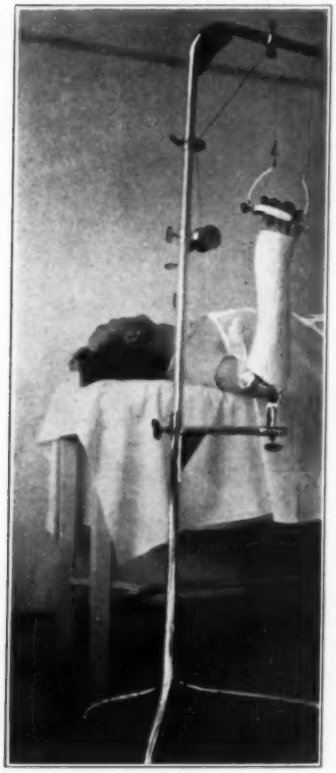

FIG. 1-A

Sokolowsky's appliance for reduction of fractures of the forearm.

FIG. 1-B

FIG. 2-A

FIG. 2-B

Fixation by skeletal pins in plaster.

The difficulty of adequate steadying of an oblique fracture of the forearm, or of a comminuted intra-articular Colles' fracture, is well known,

* Read at the Annual Meeting of the American Orthopaedic Association, Lincoln, Nebraska, June 3, 1937.

even when plaster splints are employed without padding. For these cases Böhler suggests combined fixation by means of a plaster-of-Paris dressing and two non-rusting wires passed through the bones and pulled taut, their ends embedded in the plaster. This steadying combination, a decidedly efficient one, is made easily and neatly with the aid of Sokolowsky's apparatus. (See Figures 2-A and 2-B.)

Correction

Dr. Leo Mayer of New York has requested that we publish a correction in his article entitled "The Importance of Early Diagnosis in the Treatment of Slipping Femoral Epiphysis", published in *The Journal* for October 1937. On page 1051, the eleventh line in the third paragraph should read: "The leg is then immobilized in plaster-of-Paris in a position of abduction and internal rotation."

PERCY WILLARD ROBERTS

1867–1937

Percy Willard Roberts passed away on November 8, 1937, at the Hospital for the Ruptured and Crippled, after an illness of only two days.

Dr. Roberts was born on January 10, 1867, in Janesville, Wisconsin, but he spent his early years in Milwaukee. At the age of eighteen, he went to San Francisco to become a reporter on the *Chronicle* and here earned his funds to study medicine. He graduated from Boston University School of Medicine in 1894. He then carried on a general practice in Bath, Maine, but, after ten years, the ambition to become an orthopaedic surgeon led him to New York in 1904, where he received an appointment at the Post-Graduate Hospital. The late Dr. Henry Ling Taylor recognized his ability and gave him an appointment at the Hospital for the Ruptured and Crippled in 1907, where he also worked under the late Dr. Virgil P. Gibney and on up through the various grades to Chief of a Division. He retired from active hospital work in 1934, but retained his private practice and was a consultant at many hospitals in New York.

Dr. Roberts contributed often to the literature and will be remembered for the operations and apparatus which he devised, as well as for his interest in the subject of congenital syphilis which made many realize that this disease was more often the cause of orthopaedic conditions than was formerly believed.

Dr. Roberts was always a kind gentleman, with a genial smile and a sense of humor, and was greatly admired and respected by his patients. He was always extremely mild-mannered, and even in the face of difficulties he appeared calm and unworried. Many times he went through various crises which must have perturbed him, but he never showed it outwardly. He was always loyal and cooperative and had a personality that would keep a group of men working together without friction. Those who worked with him and under him will feel a great loss in his passing.

EDWARD SPARHAWK HATCH

1875–1937

Edward Sparhawk Hatch, one of the outstanding orthopaedic surgeons of the South, died suddenly on October 20, 1937. He was born in Boston on February 2, 1875. He graduated from Harvard University in the Class of 1897 and from Harvard Medical School in the Class of 1899. He devoted a few years to general practice in Boston, but his interest soon turned to orthopaedic surgery. He became affiliated with Carney Hospital in Boston, and from that time dates his active part in this specialty.

In 1905 Dr. Hatch moved to New Orleans. He became a pioneer in orthopaedic surgery in that part of the South where he played an important rôle in the establishment of this specialty. In addition to an active private practice and to his work in research, he was Professor of Orthopaedic Surgery in the Post-Graduate Department of Tulane Medical School; chief of the Department of Orthopaedic Surgery in Tuoro Infirmary; and had also been chief of the departments of orthopaedic surgery in several of the medical institutions in New Orleans and vicinity. During the World War he served in the Medical Corps of the United States Army. Fifteen years ago Dr. Hatch opened the first clinics for crippled children in Lake Charles and Lafayette, Louisiana. He was still actively interested in the Clinic in Lafayette at the time of his death.

Dr. Hatch always took an interest and played an active part in the medical societies. He had been Chairman of the Orthopaedic Section of the American Medical Association, as well as of the Southern Medical Association, President of the Clinical Orthopaedic Society, and he was a member of the American Orthopaedic Association, the American Academy of Orthopaedic Surgeons, and a Fellow of the College of Surgeons.

In February 1937, Dr. Hatch suffered a fracture of the spine, but he did not allow this to interfere with his activity for after recovery he resumed and carried on his usual practice.

He was always a good friend, and his genial personality will be missed by his friends. He leaves a widow and two children,—a married daughter and a son.

News Notes

The Sixth Annual Convention of the **American Academy of Orthopaedic Surgeons** will be held in Los Angeles, California, January 16 to 20, 1938, under the presidency of Dr. A. Bruce Gill. The headquarters will be at the Biltmore Hotel and the following program has been arranged:

TUESDAY, JANUARY 18

Morning Session

Sacro-Iliac Fusion: A Modification of the Smith-Petersen Technique.
Dr. A. F. O'Donoghue, Sioux City, Iowa.

Two-Stage Extra-Articular Knee-Joint Fusion for Tuberculosis.
Dr. Don King, San Francisco, California.

Treatment of Extreme Flexion Contracture at the Knee Joint.
Dr. S. L. Haas, San Francisco, California.

A Procedure for the Correction of Internal-Rotation Contractures of the Thigh in Spastic Paralysis.
Dr. H. A. Durham, Shreveport, Louisiana.

The Evaluation of Surgical Procedures on Bones, Muscles, and Peripheral Nerves in Spastic Paralysis.
Dr. L. C. Wagner, New York, N. Y.
Dr. Francis J. Carr, New York, N. Y.
Dr. Arthur Thibodeau, New York, N. Y.

Executive Session—12:00 Noon

Afternoon Session

President's Address.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Non-Union and Bone-Graft Symposium—Dr. N. T. Kirk, San Francisco, *Chairman:*

Massive Onlay Graft in Ununited Fractures of the Long Bones, with Report of End Results.
Dr. Willis C. Campbell, Memphis, Tennessee.

Bone Grafts in Ununited Fractures.
Dr. M. S. Henderson, Rochester, Minnesota.

Inlay Grafts and Intramedullary Pegs in Ununited Fractures.
Dr. Edwin B. Ryerson, Chicago, Illinois.

Treatment of Non-Union of Fractures with Particular Reference to the Humerus.
Dr. G. E. Bennett, Baltimore, Maryland.

Transplantation of the Fibula in the Leg: (a) For Large Defect in the Tibia; (b) Transfer of Upper End to Restore Ankle Mortise.
Dr. W. B. Carrell, Dallas, Texas.

WEDNESDAY, JANUARY 19

Morning Session

Symposium on Fractures of the Spine—Dr. A. G. Davis, Erie, *Chairman:*

First Aid and Transportation of Suspected Spine Injuries.
Dr. J. E. M. Thomson, Lincoln, Nebraska.

Indications for Operation in Cord and the Caudal Injuries.
Dr. Howard C. Naffziger, San Francisco, California.

Evaluation and Treatment of Acute Cervical-Spine Injuries.
Dr. W. Gayle Crutchfield, Richmond, Virginia.

Cord Injury and Vertebral-Column Fracture.
Dr. William A. Rogers, Boston, Massachusetts.
Crush Fractures of the Spine.
Dr. John Dunlop, Pasadena, California.
Crush Fractures of the Spine.
Mr. R. Watson Jones, Liverpool, England.
The Treatment of Paralytic Bladder in Cases of Cord Injury.
Dr. Frank Hinman, San Francisco, California.
Rupture of the Intervertebral Disc as the Cause of Low-Back Pain with Unilateral Sciatic Radiation.
Dr. J. M. Robinson, San Francisco, California.
Tensile Strength of the Anterior Common Ligament.
Dr. A. G. Davis, Erie, Pennsylvania.

Afternoon Session

The First Stages of Coxa Plana.
Dr. Henning Waldenström, Stockholm, Sweden.
Manipulative Surgery.
Dr. Philip Lewin, Chicago, Illinois.
Manipulative Method of Treatment of Backache.
Dr. F. A. Jostes, St. Louis, Missouri.
Some Problems of Bone Growth.
Dr. J. B. deC. M. Saunders, San Francisco, California. (By invitation.)
Dr. V. T. Inman, San Francisco, California. (By invitation.)
Posterior Hernia of the Knee Joint (Baker's Cyst), a Cause of Internal Derangement of the Joint.
Dr. G. E. Haggart, Boston, Massachusetts.

THURSDAY, JANUARY 20

Morning Session

Avulsion Fractures of the Greater Trochanter of the Femur.
Dr. Henry Milch, New York, N. Y.
Opposition of the Thumb.
Dr. Sterling Bunnell, San Francisco, California. (By invitation.)
The Healing of Joint Fractures: A Clinical and Experimental Study.
Dr. K. O. Haldeman, San Francisco, California.
Healing of Fractures of Atrophic Bones: A Clinical and Experimental Study.
Dr. E. L. Compere, Chicago, Illinois.
Bone Block for Painful Hips.
Dr. J. B. L'Episcopo, Brooklyn, New York.

Executive Session—12:00 Noon

Afternoon Session

Results of Treatment of Slipping of the Upper Femoral Epiphysis by Nailing.
Dr. Philip D. Wilson, New York, N. Y.
The Operative Lengthening of the Tibia and Fibula: A Further Development in Principles and Technique.
Dr. L. C. Abbott, San Francisco, California.
Dr. J. B. deC. M. Saunders, San Francisco, California. (By invitation.)
Roentgen-Ray Evidence of Metastatic Malignancy in Bone.
Dr. Henry Snure, Los Angeles, California. (By invitation.)
Experience with Bone Tumors at the Boston City Hospital from 1932 to 1936.
Dr. R. F. Sullivan, Boston, Massachusetts.
Treatment of Fibrocystic Cavities in Bone by Curettage and Packing with Bone Chips.
Dr. W. E. Swift, New York, N. Y.
Dr. Halford Hallock, New York, N. Y.

Dr. Frank R. Ober, Assistant Dean of the Harvard Medical School, has been made Professor of Orthopaedic Surgery at the University of Vermont.

Prof. Etienne Sorrel, of Paris, announces the removal of his office to 123, rue de Lille.

Dr. William J. Stewart announces the opening of an office at 401 Guitar Building, Columbia, Missouri.

The Seventh Walter M. Brickner Lecture was given at the **Hospital for Joint Diseases** on Thursday evening, November 18, 1937, by Dr. Sterling Bunnell of San Francisco. The subject of the lecture was "Reconstructive Surgery of the Injured Hand".

A joint meeting of the **Deutsche Gesellschaft für Chirurgie** and the **Deutsche orthopädische Gesellschaft** will be held in Berlin on April 21, 1938, at the Langenbeck-Virchow-Haus. The special subject for discussion will be "Traffic Accidents".

The Third Annual Meeting of the **Orthopaedic Guild** was held on November 26 and 27 in Richmond, Virginia, with Dr. T. F. Wheeldon as Chairman. The next Meeting will be held in Toronto on November 25 and 26, 1938, under the Chairmanship of Dr. A. W. Farmer.

The **Polish Society of Bone and Joint Surgery and Traumatology** will hold its next meeting in Poznan on April 2 and 3, 1938. The discussion at this meeting will be confined to two subjects: "Infantile Paralysis", by Prof. Raszeja; and "Interarticular Fractures", by Prof. Gruca.

The Sixty-Seventh Annual Meeting of the **American Public Health Association** will be held in Kansas City, Missouri, on October 25 to 28, 1938. Dr. Edwin Henry Schorer, Director of the Kansas City Health Department, has been appointed Chairman of the Local Committee. He will be assisted by a large group of city and state officials and community leaders.

The **Clinical Orthopaedic Society** met in Chicago on October 14, 15, and 16, to celebrate its Silver Anniversary and to honor Dr. John Lincoln Porter, its first President.

Most interesting and instructive clinics were presented at Cook County Hospital, the Research and Educational Hospitals of the University of Illinois, St. Luke's Hospital, Albert Merritt Billings Hospital, and Northwestern University Medical School.

The meeting was climaxed by the annual banquet held on Friday, October 15, at the Palmer House. The banquet was under the direction of Dr. J. E. M. Thomson, President of the Society, and Dr. Albert H. Freiberg, Toastmaster. A gold medal with the inscription "To Dr. John Lincoln Porter, The Founder of The Clinical Orthopaedic Society" was presented to the guest of honor by Dr. A. Bruce Gill. A short acceptance address was made by Dr. Porter in his usual sincere and modest style. Bronze medals of Dr. Porter, made from a wood carving by Dr. J. E. M. Thomson, were presented to the members. The John Lincoln Porter Lecture was given by Dr. Willis C. Campbell, who spoke on the subject of "Malunited Fractures". Additional remarks were made by Dr. Samuel Kleinberg, Dr. E. W. Ryerson, Dr. Melvin S. Henderson, Dr. Arthur Steindler, and Dr. Philip Lewin.

The next meeting will be held in Nashville and Birmingham during the Fall of 1938.

The Twelfth Congress of the **Deutsche Gesellschaft für Unfallheilkunde, Versicherungs- und Versorgungsmedizin** was held in Würzburg on September 24 and 25, 1937, under the presidency of Prof. Dr. Reichardt, the distinguished alienist.

The very full and interesting program, although devoted chiefly to psychological and neurological subjects, included the following communications of orthopaedic interest:

Dr. Vogler, of Stettin, reported on lumbar puncture in head injuries, with especial reference to American practices. He demonstrated the good results of this method by a large amount of statistical material.

Dr. Demme, of Hamburg, discussed nerve injuries caused by intramuscular injection. His experiments on animals proved that India ink injected into the nerves of the leg penetrated the nerve roots.

Dr. Wanke, of Kiel, described his investigations on the lumbago and scalenus-muscle syndrome.

Of especial interest was the discussion by Dr. vom Stracke, of Erlangen, on the so-called traumatic neurosis.

The next Congress will be held in Giessen in 1939 under the presidency of Prof. Dr. A. W. Fischer.

The Nineteenth Congress of the **Société Française d'Orthopédie et de Traumatologie** was held in Paris on October 7, 8, and 9, 1937, under the presidency of Prof. Etienne Sorrel.

The "Orthopaedic Days", October 7 and 8, were spent in visiting the Services of Prof. Ombredanne, Dr. Mathieu, Prof. Sorrel, Dr. Leveuf, and Dr. Boppe, where operations were demonstrated and patients were presented.

Prof. Sorrel opened the Congress with a paper on the growth of orthopaedics in France and its present tendency to become more and more surgical. He expressed the hope that France would soon follow in the wake of other countries and establish services devoted exclusively to orthopaedic surgery.

The two main subjects considered by the Congress were as follows:

The Transplantation of Tendons in the Treatment of Club-Foot—Dr. Jacques Leveuf, of Paris, and Dr. A. D. Perrot, of Geneva.

The first part of the discussion was confined to three topics:

1. The conditions necessary for a successful transplantation:
   a. Integrity of the muscle itself.
   b. Integrity of the structures used for the protection of the tendon.
   c. Fixation of the tendon.
   d. Tension on the transplanted muscle.
   e. Postoperative care.
2. Functional adaptation of the transplanted muscles.
3. Reestablishment of the muscular equilibrium.

The second portion of the report dealt with the special indications for transplantation of tendons in the following conditions: (1) paralysis of the triceps surae; (2) paralysis of the tibialis anterior; (3) paralysis of the supinators; (4) paralysis of the pronators. The use of this procedure in pes equinus and pes cavus was also discussed, although these affections are not the direct result of paralysis.

Bilateral Coxalgia—Dr. Louis Allard, of Berck.

After having given the clinical description of bilateral coxalgia and its prognosis, Dr. Allard confined himself to the treatment of this affection. He concluded that the treatment should first strive for anatomical cure of the focus in good position. After this has been obtained, one should use the utmost care to prevent sequelae. Each case has its own indications. Among the procedures to be considered are those simple operations without danger,—namely, osteotomy for correction and arthrodesis in certain cases. Operations for mobilization should be seriously debated and should not be advised without warning the patient of possible failure. Dr. Allard favored the plastic

intertrochanteric osteotomy which preserves intact the musculature and leaves the abductors attached to the trochanter.

The remainder of the Congress was devoted to the presentation of the following papers:

Vertebral Aspects of Paget's Disease—Dr. Charles Lasserre, of Bordeaux.

Blood Chemistry in Various Diseases of Bone—Dr. Charles Lasserre and Dr. L. Servantie, of Bordeaux.

Slipping of the Patella—Dr. Guilleminet and Dr. Brunat, of Lyons.

Correction of Scoliosis by Plaster Cast—Dr. Lucien Michel, of Lyons.

Chondrodystrophy with Widening and Flattening of the Vertebrae (Platybrachyspondylia)—Dr. R. Guérin and Dr. P. Lachapèle, of Bordeaux.

Congenital Luxation of the Atlas through Malformation of the Axis—Dr. Lombard and Dr. Le Génissel, of Algiers.

Infantile Kyphosis—Prof. Frejka, of Brno.

Fractures of the Upper End of the Radius, with a Report of Seventeen Cases—Dr. H. L. Rocher, of Bordeaux.

Arthroereisis with "Os Purum"—Dr. P. Marique, of Brussels.

Drilling of the Neck of the Femur in Arthritis Deformans of the Hip—Dr. R. Charry and Dr. G. Charry, of Toulouse.

Roentgenography of the Articulations—Dr. F. Pouzet, of Lyons.

Tibia Vara—Dr. Pouzet, of Lyons.

Astragalectomy—Dr. Petrov, of Sofia.

Congenital Deformities—Dr. Nicod, of Lausanne.

Deformities of the Menisci of the Knee—Dr. Dieterich, of Mulhouse.

The next Congress will be held in Paris on October 7, 1938, at the *Faculté de Médecine de Paris*, under the presidency of Prof. H. L. Rocher, of Bordeaux. The subjects to be discussed are: "Painful Vertebral Kyphosis Due to Dystrophy" and "Simultaneous Fractures of the Shafts of Both Bones of the Forearm".

The Society will visit the orthopaedic centers of the important cities of Switzerland at the end of September 1938.

The Congress of the **Yugoslavian** and **Czechoslovakian Orthopaedic Societies** was held in Belgrade, on October 18 and 19, 1937. Prof. Dr. Rocher of Bordeaux, Prof. Dr. Gruca of Lwow, Poland, Prof. Dr. Raszeja of Poznan, Poland, and Prof. Dr. Boićev of Bulgaria, were present as guests, and there were representatives from all the Slavic countries except Russia. The principal subject of discussion was "Congenital Dislocation of the Hip".

Docent Dr. Jovćić called attention to the prevalence of congenital dislocation of the hip in Yugoslavia and estimated that there were about 30,000 cases in his country. He reported that, in a total of 900 cases which he had treated, the best results had been obtained in patients under two years of age, both anatomical and functional results at this period being 100 per cent. successful. Correct replacement and treatment by the use of plaster bandages require real skill and should only be attempted by those who are highly experienced.

The second speaker, Prof. Zahradníček, presented the operative treatment of this luxation. He regards subtrochanteric osteotomy of the Kirmisson-Lorenz-Schanz type as an erroneous procedure, which should be used only when the anatomical changes are of too pronounced a character or when the patient will not agree to a radical operation. The radical operations performed in Prof. Zahradníček's clinic are of three types: (1) operative replacement without shortening of the femoral bone, either with or without the shelf operation (this method is suitable mainly for small children in whom not much shortening takes place and the soft parts, notably the articular capsule, present an anatomical obstacle to replacement); (2) operative replacement and shortening of the femoral bone, with the shelf operation, which is necessary in luxations with con-

siderable shortening (in this operation the anteversion is adjusted at the same time); (3) detorsion operation by an oblique intertrochanteric osteotomy, used with the shelf operation in cases of subluxation combined with anteversion and valgosity of the neck. He reported satisfactory results in adolescents and in adults, but emphasized the need of operation where possible in early childhood—between the ages of three and six years—as the results are better than at a later age.

Prof. Spišić showed a film demonstrating the non-operative treatment and emphasized the need for instruction of the general public so that congenital dislocation could be treated at as early an age as possible. In his treatment he used also Putti's and Hilgenreiner's splints.

Prof. Rocher discussed the end results obtained by the non-operative treatment. Examination ten or more years after replacement showed subluxation and deformation of the head in most of the cases. He believes that every dislocation should be kept under x-ray control until adolescence.

Prof. Frejka emphasized the need of training the medical profession to treat dislocations as early as possible,—at the age of one and one-half years at the latest. The teaching that results will be equally successful after the second year encourages delay in reposition. He demonstrated the good results obtained by detorsion operations in which he used Zahradníček's method, which he prefers to the simpler shelving operation without reposition and without adjustment of anteversion. He showed several cases of operative replacement by the Zahradníček method.

Dr. Pavlanský discussed the necrosis of the head which occurs in the course of non-operative treatment, and showed that this is frequent after non-operative replacements, particularly when the luxation is high. After operative replacement and detorsion osteotomy, he had not observed necrosis of the head. In Prof. Zahradníček's Clinic, cases are treated non-operatively up to the age of three or three and one-half, and, after the third year, by operation. Necrosis of the head is thought to be the result of ischaemia arising from strain of the capsule at the time of the reduction.

There was also discussion by Prof. Mikula, Dr. Janek and Dr. Mestrić, Dr. Alberti, Dr. Delić, Dr. Vlašić, and Dr. Ambrožić, who gave their experiences with the treatment of this disorder.

The second main subject dealt with was "War Injuries of Bones and Joints". Dr. Florschütz spoke of methods of treatment, and Dr. Danić placed the blame for the bad results during the War on the organization of the work, and emphasized the necessity of these cases being in charge of and treated by men of experience.

Papers were presented by Prof. Zahradníček on his operation for spondylolisthesis and by Prof. Frejka on infantile kyphosis. Prof. Spišić showed a film on the treatment of contractures of articulations by plaster bandages and the Quengel method. Dr. Janěk spoke of the significance of the gonococcus reaction in articular diseases. Dr. Jovćić demonstrated the results of reductions of traumatic dislocation of the hip. Dr. Grospić showed slides to illustrate the results of plastic operations on the knee, the hip, and the elbow. Dr. Delić spoke on spine grafting, and stated that in the most severe cases of thoracic gibbosity he uses a solid bone graft introduced above or below the gibbosity by transversectomy. Dr. Stojadinović demonstrated the results of treatment of cysts of the bone. Dr. Savić showed slides to illustrate the results of operative replacement of old dislocations of the shoulder and the elbow.

The Congress closed with a reception at the Belgrade Aero-Club. The next Congress will take place in Prague early in July 1938, at the same time as the Pan-Slavonic Medical Congress and the Pan-Sokol Railly. The principal subjects will be "Pseudarthrosis", to be discussed by Prof. Zahradníček, and "Necrosis of Bone", by Dr. Frejka.

BRITISH ORTHOPAEDIC ASSOCIATION

The Annual Meeting of the British Orthopaedic Association was held in Sheffield on October 29 and 30 under the Presidency of Mr. W. R. Bristow. A large number of

members and guests were present and enjoyed a most stimulating program. The Association Dinner was held at the Royal Victoria Hotel. The guests included the Chairman of the Royal Infirmary and the Vice-Chairman of the Children's Hospital, as well as many distinguished members of the University and Hospital Medical Staffs. Prior to the dinner, visits to one of the large steel works and to a coal mine had been most interesting interludes in the scientific proceedings.

The scientific program was divided into two parts, as follows:

I. A Clinical Demonstration which was given in the Out-Patient Department of the Sheffield Royal Infirmary. Many patients illustrating the results of treatment of fractures and of diseases and neoplasms of the locomotor system were shown by Mr. S. W. Daw, of Leeds, and Mr. J. B. Ferguson Wilson, Mr. C. Lee-Pattison, Mr. Arthur M. Connell, and Mr. F. W. Holdsworth, all of Sheffield.

II. The Presidential Address and a series of short papers which occupied two mornings at the Medical Library of the University.

Orthopaedic Surgery—Retrospect and Forecast by Mr. W. R. Bristow, London

The President traced the post-war growth in Orthopaedic Surgery which had proceeded *pari passu* with specialization in other surgical fields. Decentralization was increasing, especially in orthopaedic surgery, and was causing the university hospitals some difficulty in obtaining representative clinical material for the purposes of student teaching. It was suggested that this difficulty might be overcome by closer cooperation between city and country hospitals. The President also outlined the changes which would have to take place, as a result of multiple special departments, in the curriculum of the student during his hospital training so that he could have practical experience in each branch of Surgery.

Treatment of Minor Injuries by Mr. W. G. Campbell, Dundee

A detailed account was given of the early treatment of strains of ligaments and muscles by the injection of a local anaesthetic into the site of tenderness. It was assumed that Leriche's conception of strain is the right one,—namely, that there is no tearing of ligamentous fibers, but apparent impulses passing from the "damaged" area begin a vicious circle of local vasodilatation, metabolites, etc. In a comparative series of patients Mr. Campbell found that treatment by this method had resulted in cure in about three days, as compared with twelve days by the conventional method of strapping, etc.

The Correction of Spinal Kyphosis by Means of a Continuously Adjustable Bed by Mr. R. W. Butler, Cambridge

With diagrams and a model, Mr. Butler demonstrated in detail how to make and to use his ingenious sectional plaster-of-Paris bed for the correction of anteroposterior deformities of the spine.

Ossification of Ligaments of the Elbow Joint by Mr. St. J. D. Buxton, London

The frequency of ossification in the ligaments following injuries, especially dislocations, was stressed. It was emphasized that the amount of ossification is governed largely by the treatment of the injured joint. If rested for an adequate period (several weeks), no harmful amount of ossification results, but if efforts are made early to force movements, then extensive new bone formation often occurs and the mobility of the joint is seriously restricted for all time.

Undulant-Fever Osteitis by Prof. Green, Sheffield

A most interesting review of the literature on this rare fever was presented and various features of it demonstrated from the records of a patient under Prof. Green's care. Bones and joints are frequently involved and abscesses form which usually resolve quickly without persistent sinuses. The roentgenographic changes in the bony lesions are not typical and may resemble those seen in tuberculous disease. Ankylosis of joints is rare and the general prognosis is good.

Some Principles of Joint Mechanics by Mr. M. A. McConaill, Sheffield

In a most stimulating résumé, Mr. McConaill presented his views on joint mechanics derived from six years of anatomical investigation. He maintained that the chief function of the specific synovial fluid is to prevent friction,—a function which is least active during the full coaptation of the joint surfaces in weight-bearing. Hence degenerative changes occur most frequently on those surfaces which fit together best. The ligaments are not elastic and are so arranged that they act to prevent the harmful effects of torsion. Mr. McConaill's thesis was new to many members of the Association and it evoked much enthusiastic interest. It is to be hoped that his work will be available in written form later.

Some End Results of Bone and Joint Tuberculosis by Mr. J. C. Scott, Oxford

Mr. Scott presented a preliminary report of an end-result survey of 582 patients suffering from tuberculous disease of the spine and of the hip joint. As far as possible the results of conservative treatment alone were contrasted with those in which conservative treatment had been reenforced by operative measures. The combined procedure appeared to have a slight advantage.

Certain Injuries of the Carpus by Mr. J. L. Grout, Sheffield

Mr. Grout reported his findings in an x-ray investigation of the wrists and hands of some thirty-nine workers who use pneumatic drills and chisels. In a little less than half of the men, small cystlike spaces, giving rise to no symptoms, were found in the carpal and metacarpal bones. No explanation of these cysts is available at present. Osteo-arthritis of various joints was a common finding.

The Early Diagnosis of Malignancy in Bone Tumors by Dr. J. F. Brailsford, Birmingham

Dr. Brailsford gave for the most part an excellent résumé of the present-day attitude in relation to the diagnosis and treatment of malignant bone tumors. He emphasized the difficulties in diagnosis in general, and of x-ray interpretation in particular. In doubtful cases he prefers to be guided by serial roentgenograms, and he differs substantially from his surgical colleagues in condemning the routine use of biopsy. If the latter *is* used, the area selected for the removal of tissue should be determined with precision beforehand by the roentgenologist. Dr. Brailsford made a strong plea for closer cooperation between the clinician, the pathologist, and the roentgenologist.

Nephrolithiasis Occurring in Recumbency by Mr. R. Guy Pulvertaft, Grimsby

The cases of sixty patients, who, during long periods of immobilization in recumbency for tuberculous bone or joint lesions, had developed renal calculi, were reviewed. The factors responsible for stone formation appear to be defective renal drainage and the wide-spread skeletal and muscular decalcification. Preventive measures consist of frequent "turnings" of the patient, avoidance of excessive exposure to the sun, and a generous fluid intake. A minority of stones require operative removal. The majority are passed as "gravel" when "turnings" are commenced or when the patient becomes ambulatory.

Arthrodesis of the Hip by Mr. R. Watson Jones, Liverpool

The technique of intra-articular arthrodesis, followed some ten days later by the "closed" introduction of a long Smith-Petersen nail along the femoral neck deeply into the ilium, was described. It was claimed that the combined procedure had greatly increased the chances of securing bony union. The excellent results achieved were demonstrated in a very instructive film. Mr. Watson Jones referred briefly to the method, still on trial, of fixing the osteo-arthritic hip by a long Smith-Petersen nail introduced through a short incision without a preliminary denudation of the articular surfaces. This procedure obviously is more applicable to older people than is the combined operation, and the results so far have been encouraging.

Current Literature

THE MANAGEMENT OF FRACTURES, DISLOCATIONS, AND SPRAINS. John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. Ed. 2. St. Louis, The C. V. Mosby Co., 1937. $12.50.

This new edition is larger and more attractive than the first. Again the authors have produced a book which is a good working guide for the surgeon, practitioner, or student. The same arrangement as in the first edition—Part I: Principles and General Aspects; and Part II: The Diagnosis and Treatment of Specific Injuries—is retained. Many chapters have been slightly altered; there are some new illustrations, and, in certain places, better illustrations have been substituted.

As in the previous edition, there are excellent and unusual chapters dealing with the Workmen's Compensation Law as it affects fracture cases and the medicolegal aspects of fracture cases.

The chapters on "Fractures of the Skull and Brain Trauma" by C. E. Dowman and "Fractures of the Jaws and Related Bones of the Face" by J. B. Brown have been rewritten. The alterations in the latter chapter are the most radical in the book. The illustrations in this chapter are numerous and excellent and the text shows evidence of a great deal of careful study.

Injuries of the spine are discussed from the point of view of today's treatment. Much has been added in regard to the treatment of compression fractures. A discussion of rupture and herniation of the intervertebral discs, a subject of much interest and concern at the present time, has been included for the first time. However, fourteen lines with no illustrations seems like an inadequate presentation of such an important subject in a chapter of ninety-four pages on spine injuries.

This book is very interesting. The experiences of the authors seem to dovetail very nicely. Wherever there is a difference of opinion or in technique, both opinions are given. This second edition contains no revolutionary changes, but represents a modernization of the previous volume.

TABLE GÉNÉRALE DES ANNÉES 1908–1932 DU JOURNAL DE CHIRURGIE. Établie par J. Dumont et P. Grisel, avec la collaboration de M^me^ J. Dumont. Paris, Masson et C^ie^, 1937. 260 francs.

This book is an index of the original papers and articles abstracted in the first forty volumes of *Le Journal de Chirurgie*. This material has not been classified according to the usual alphabetical order, but according to the subject matter, as is the custom in the monthly issues of this publication. The references are first arranged under general headings such as "Surgical Pathology", "Skin", "Cartilage", "Bone", "Muscles", etc., and subdivided, and then they are grouped under regions with their structures. In this way is made easily available all of the material which has been published in these forty volumes with reference to a particular subject. The references are arranged chronologically according to the volume in which they appeared.

As an added convenience, the editors have placed at the beginning of the volume an index of the original articles arranged alphabetically according to the authors.

As is explained by Dr. Grisel in the Foreword, the index covers the abstracts from April 1, 1908, to December 1, 1932, but it includes the original articles up to December 1935.

This book should be a valuable addition to the physician's reference library.

THE THINKING BODY. A STUDY OF THE BALANCING FORCES OF DYNAMIC MAN. Mabel Elsworth Todd. New York, Paul B. Hoeber, Inc., 1937. $4.00.

After many years of practical experience and special study combined with laboratory investigation, Miss Todd has presented her original views on this general subject

of physiotherapy. This work is considered through quite a new approach, and the author carefully avoids any claim to a school or system but aims to present, more or less originally, the principles involved in utilizing the coordination of the related functions of the body. As its title indicates, the book is not a treatise dealing with the conventional acceptation of the subject of physiotherapy, but represents the result of an individual study and investigation of the physical and psychological influences which underlie body development.

From the beginning of her work on this particular form of therapy, the author emphasizes the value of the coordinating movements and the necessity of understanding and cooperation on the part of the patient. One of the principal objects of the book is to aid those who are engaged in the practice of physiotherapy to obtain body balance in such a way that it may be a factor in daily life and correct the ill effects which result from body imbalance. The author wisely emphasizes the influences which are attributable to psychology and gives to them more prominence than is usually found in textbooks dealing with this subject. She emphasizes the necessity of a thorough understanding of anatomy, physiology, and nerve control in order to appreciate the important part which they play in the movements of the body. This forms the basis on which her theories are founded and put into execution.

The special functions, such as breathing, walking, etc., are analyzed in detail. Posture, both normal and defective, is given adequate consideration, and the discussion of the principles of correction of posture defects and the methods of accomplishing this correction will be found to contain much that is original. The skeletal and muscular systems and their combined action in the development and maintenance of the normal body balance are given special prominence, with a very full discussion of the fundamental rôle which they play, as well as the importance of their coordination.

In this unique presentation, the reader will find much to interest and to aid him in the performance of his daily work, even though he may not always agree with all of the theories and practices.

PHYSICAL THERAPY IN ARTHRITIS. Frank Hammond Krusen, M.D. Foreword by Melvin S. Henderson, M.D. New York, Paul B. Hoeber, Inc., 1937. $2.25.

Arthritis has been termed the "stepchild" of Medicine, but there can be no stepchild without a step-parent. The author has commendably applied himself to the preparation of this little book, primarily as a guide for the general practitioner. This appears to have been done with a realization of the fact that insufficient familiarity with the possibilities of physical therapy and with its technique are largely responsible for the defeatist attitude often assumed by the physician. Having disposed of foci of infection as well as may be and having employed various drugs and sera, he finds that arthritis still remains to be treated. In this situation, he is only too often found uninformed regarding the applicability of the various methods to the case in question, or under the mistaken impression that they are available only through institutional care.

To the author's credit it must be said that he has successfully striven to give a more correct conception of the situation to the reader. His descriptions are clear and well suited to the compendious form which he has chosen. Perhaps it may be said that, in his desire to give credit to those who have contributed to the literature of the subject, his text abounds in a superfluity of quotations which does not add to its clarity, especially since the complete references are also given. While the various methods in use are sufficiently described, there is an admirable lack of excessive emphasis upon the need for those whose value is not generally accepted. It must be admitted, however, that in a number of instances methods and apparatus are portrayed whose employment would be precluded in any but the more commodious homes or well-equipped institutions. This but emphasizes the fact that, while those arthritics who have abundant means may and do engage in the elusive search of a climate which will cure them and the services of well-staffed institutions, there is a general and unfortunate paucity of provision for

sufficiently extended care of those in less fortunate economic situations. It would seem difficult to agree, without considerable qualification, with the author's final sentence:

"With a little ingenuity the family physician can supply nearly all the necessary physical therapy in the patient's own home."

BEITRAG ZUR KENNTNIS DER ANGEBORENEN HÜFTGELENKSVERRENKUNG (A Contribution to Our Knowledge of Congenital Dislocation of the Hip). Dr. Max René Francillon. (Beilageheft zur Zeitschrift für Orthopädie, Bd. LXVI.) Stuttgart, Ferdinand Enke, 1937. 9.80 marks.

One hundred and ninety-six cases of congenital dislocation of the hip were reviewed primarily in the interest of "ischiometric" determinations. In the course of the follow-up examinations, a critical study of the end results furnished interesting data. These, with comparative studies from other sources, have been expanded to form a comprehensive monograph.

The ratio of eight females to one male, instead of the usual six to one, is explained on anthropological grounds. The accurate diagnosis and prognosis in the luxated hip, and particularly in the subluxated hip, entail careful study of the development and position of the osseous center of the head, of Shenton's (better Menard's) line, and of the degree of ossification of the ischiopubic synchondrosis. Both the developmental and the mechanical factors in the causation are variables.

Retarded development is evident in the delayed ossification of the ischiopubic synchondrosis, the os acetabuli superior, and the osseous center of the femoral head, as well as the persistent anterior torsion of the femur. The retroversion and shape of the femoral head are discussed. An extensive review of the frequent osteochondral lesion of the head leads to the conclusion that it is a peculiar reaction of the bone (probably with several exciting causes) and not a specific disease.

"Ischiometric" determinations as suggested by Scherb are recorded in three cases to illustrate how this clinical-mathematical observation supplements the roentgenographic findings in determining the shape of the femoral head and the condition of the joint cartilage.

Detailed anatomical studies are well illustrated.

TISSUE REACTIONS IN BONE AND DENTINE. A MORPHO-BIOLOGICAL STUDY OF THE FORMATION AND THE DISSOLVING OF BONE AND DENTINE. Åke Wilton, M.D. London, Henry Kimpton, 1937.

This 194-page book reflects a great deal of meticulous work and serious thought on the subject of determination and differentiation in bone and dentine. The presentation is clear and scholarly. There are many good illustrations, of which several are in color. A comprehensive bibliography is appended.

The author's own investigations, consisting of nine years of careful histological study of the normal and the pathological development of bone and dentine, are recounted after a complete review of the literature. The author has introduced to the subject what he terms an "N-factor", which brings about abnormally slow differentiation and decrease in growth, acting generally on the tissues of the connective system, and most strongly where the rate of growth is greatest. The skeletal deformities in rickets and achondroplasia are thought to be caused by the action of this N-factor on the normal endochondral ossification. By comparative studies of the arrest of development of cartilage, bone, and teeth in achondroplasia, the N-factor is shown to act during foetal life in inverse proportion to the degree of determination and differentiation of the tissues.

The author has made a study of osteolysis in experimental osteitis fibrosa cystica, scurvy, Paget's disease, osteogenesis imperfecta, senile osteoporosis, and the dissolution of transplanted bone grafts. The author has found that vitamin-C deficiency produces an abnormal dedifferentiation with abnormal proliferation of the dentine and bone,

and considers the scorbutic dentine alterations in guinea-pigs clear proof that a tissue may grow—that is, increase its number of functioning tissue elements—by dedifferentiation of previously differentiated cells. During healing, redifferentiation takes place. In Paget's disease it is shown that osteolytic foci arise by dedifferentiation of differentiated bone cells (osteocytes). Giant cells and a granulation-like tissue (Virchow's tissue) then arise to proliferate into the atrophic periosteum. On redifferentiation, bone formation occurs outside the original compact, and, by repetition of the process, increase in breadth takes place. In osteogenesis imperfecta, osteolysis occurs as in scurvy, in the main, and alterations are most pronounced in the parts most highly differentiated (tuber parietale). The alterations in scurvy and osteogenesis imperfecta are presumed to be produced by what the author calls a "W-factor". He defines this factor as one which brings about abnormal dedifferentiation with abnormal increase in growth, acting generally on the tissues of the connective system and most strongly where the rate of growth is least. Consequently, the "N" and "W" factors stand in a certain antagonistic relation to each other. They have nothing to do with the real genesis of the diseases, however. The prevailing classifications of bone resorption are discussed, and reclassification is suggested under the headings: active, passive, and lingering resorption.

This book is highly recommended to all who are interested in the pathological physiology of bone and teeth.

Chronic Rheumatic Diseases: Being the Third Annual Report of the British Committee on Chronic Rheumatic Diseases Appointed by The Royal College of Physicians. Edited by C. W. Buckley, M.D., F.R.C.P. New York, The Macmillan Co., 1937.

This third report of the British Committee is well up to the standard of the other two volumes and brings out many points of interest for the student of rheumatic diseases.

The first chapter is a summary of the evidence against vaccine therapy. Sympathectomies are discussed with the following conclusion: So long as the cause of the disease remains unknown, operations on the sympathetic system should be regarded as purely symptomatic treatment, not as direct treatment of the disease. There is an excellent paper on x-ray therapy. The best results are obtained in inflammatory processes of the joint capsule and in periarticular inflammations. The newer knowledge of avitaminosis in rheumatoid arthritis shows that vitamin A and vitamin C in the serum are subnormal. Vitamin B is probably deficient as well, but this has not yet been demonstrated. In the chapter on chrysotherapy, the author concludes that, in the present state of knowledge, this form of therapy is of value in rheumatoid types of arthritis. There is an excellent chapter by Hench on recent investigations of diseases of joints and related structures in America, with a profuse bibliography.

The book gives one a great deal of food for thought and the sense that progress in the treatment of chronic rheumatic diseases is being made. It is well worth careful study.

Carcino-Osteogenic Sarcoma—A Malignant Mixed Tumor of the Chest Wall: Report of a Case. J. W. Budd and Frank J. Breslin. *The American Journal of Cancer*, XXXI, 207, Oct. 1937.

The authors report a tumor occurring in the subcutaneous tissues just above the breast in a woman of fifty-nine. This tumor had been present for many years and grew rapidly for a year before operation. Following local removal, the patient has remained well for four years. Numerous photomicrographs illustrate the extraordinary pathology of the tumor, consisting in rapidly growing neoplastic epithelium and osteogenic tissue.

It seemed probable to the authors that there had been a sarcomatous transformation of the connective-tissue stroma of the carcinoma and that this sarcoma had assumed osteogenic properties.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

THE CORRELATION BETWEEN SERUM PHOSPHATASE AND ROENTGENOGRAPHIC TYPE IN BONE DISEASE. Helen Quinby Woodard and Norman L. Higinbotham. *The American Journal of Cancer*, XXXI, 221, Oct. 1937.

The authors have continued their studies on serum phosphatase and report in detail their findings in 203 persons with normal, benign, and malignant bone conditions seen at the Memorial Hospital. In general these findings confirm the conclusions reached in their earlier paper,—namely, that serum phosphatase is an indication of the amount of new bone formation taking place in the body, or of the attempt on the part of the body to form new bone, and is a measure of the functional rather than the histological type of the disease.

The paper presents detailed tables of the cases of primary and metastatic malignant tumors, with the determinations carried out in them.

The authors draw the following conclusions:

1. If a high serum phosphatase is found associated with an osteoplastic lesion or a normal serum phosphatase with an osteolytic lesion, then the phosphatase determination has served only to confirm the diagnosis made by the roentgenogram.

2. If a normal serum phosphatase is found associated with an osteoplastic lesion, then the process is probably slow growing and relatively benign.

3. If a high serum phosphatase is found associated with an osteolytic lesion, several possibilities present themselves:

   a. The case may be one of hyperparathyroidism. If this is so, the serum calcium and inorganic phosphorus will nearly always be abnormal and will serve to establish the diagnosis.

   b. There may be osteoplastic disease elsewhere in the body, which will account for the high serum phosphatase, even though the presenting lesion is osteolytic.

   c. The case may be one of a group made up chiefly of endotheliomata or carcinomata of diverse origin, metastatic to bone, which raise the serum-phosphatase level, but for some unknown reason do not form new bone. The presence of an elevated serum phosphatase may serve to distinguish these lesions from various types of benign osteolytic disease, which very seldom raise the serum phosphatase.

   d. The case may be one of an early highly malignant osteogenic sarcoma. Some of these fail to show new bone formation, probably because their very rapid growth rate outstrips the relatively slow deposition of calcium phosphate. Such tumors may show osteoplasia later in the course of the disease. In these cases the association of a high serum phosphatase with a rapidly growing osteolytic lesion probably indicates a high degree of malignancy.

4. Follow-up determinations of the serum phosphatase in cases with an initially elevated phosphatase may predict the development of metastases after the extirpation of the primary tumor, but cannot be depended on to do so.

5. Determinations of serum phosphatase in cases of bone tumors which have been treated by roentgen or gamma rays are useful in indicating the degree and permanence of the inactivation caused by irradiation.

6. While the presence of a normal serum phosphatase gives no assurance that bone disease is absent, the presence of a persistently elevated serum phosphatase in a patient who is not jaundiced and who is not under treatment with Coley's toxins is a very strong indication that bone disease is present and should never be disregarded.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

TRAUMA AS A FACTOR IN POTT'S DISEASE. Max H. Skolnick. *The American Review of Tuberculosis*, XXXVI, 429, Sept. 1937.

That trauma has a definite relationship to later development of Pott's disease is brought out by the author. Considerable time may elapse between the trauma and the

development of active disease, and the slighter forms of trauma seem to be a greater causative factor than severe injury. Symptomatology plays the most important part in the early diagnosis. Considerable time is required for such lesions to become clinically and objectively manifest, but if roentgenograms were taken in every case where symptomatology indicates possible activity, many cases would be discovered before irreparable damage had resulted.—*Clarence A. Ryan, M.D., Vancouver, B. C., Canada.*

INTERNAL FIXATION IN FRACTURES OF THE NECK OF THE FEMUR. Willis C. Campbell *Annals of Surgery*, CV, 939, 1937.

The author states that there are three types of fractures of the neck of the femur. The intracapsular or complete central type comprises about 43 per cent. of these fractures. It is in this type of fracture that non-union so frequently occurs. In the impacted and intertrochanteric types union can be expected in 100 per cent. of the cases.

The causes of non-union are impaired circulation to the proximal fragment, osteoporosis, inaccurate reduction, the sheering action of weight-bearing, the deleterious action of the joint fluid, and deficient blood clot. Lateral roentgenograms aid in determining whether or not a reduction has been accomplished.

For the treatment of the intracapsular type, Whitman in 1904 published his abduction plaster-fixation treatment by which union can be secured. In a survey made by a committee appointed by the American Orthopaedic Association in 1929 it was found that in 50.4 per cent. of 201 cases selected from well-known clinics bony union had been secured by the Whitman method in the complete central or intracapsular type of fracture.

The author was an adherent of the Whitman procedure, but now believes that internal fixation gives a higher percentage of excellent functional results and bony union, and decreases the time of non-weight-bearing from six to twelve months to four to six months, with less damage to the knee and hip joints. The author employs blind nailing, using the Smith-Petersen nail, and has so treated thirty-five cases of the intracapsular type.

A follow-up report of these cases is included in detail. The operative technique is described and illustrated.—*N. T. Kirk, M.D., San Francisco, California.*

THE REGENERATION OF BONE TRANSPLANTS. Hans May. *Annals of Surgery*, CVI, 441, Sept. 1937.

A review of the literature on this subject is presented and the author describes his own research as follows.

An investigation directed to the process of vascularization of a bone graft was carried out by subperiosteally removing the radius (including its two articular ends), placing the removed bone in salt solution and then replanting it in its original bed, and suturing the periosteum and closing the joint capsules. Twenty-five such experiments were performed on dogs, but aseptic healing occurred in only four animals. X-rays were made every eight days. The dogs were killed after five weeks, ten weeks, four months, and ten months, followed immediately in each case by injection of the axillary artery with a turpentine-mercury solution. The radii were removed, x-rayed, and studied histologically with the following findings:

The graft always dies after transplantation; many nucleii disappear, others degenerate, but in from two and a half to four months regeneration occurs by creeping substitution of dead bone by new bone. Small and large vessels grow from the periosteum into the graft; the former early regress as the large vessels progress until the entire graft is supplied by a well-arranged vascular system. That part of the graft not covered by periosteum becomes destroyed by ingrowing fibrous tissue and only small portions are saved by surviving osteoblasts. The periosteum, therefore, is the reliable factor in regeneration when an entire bone, with its closed medullary cavity, is transplanted.—*N. T. Kirk, M.D., San Francisco, California.*

INTERNAL FIXATION OF FRACTURES OF THE NECK OF THE FEMUR. Melvin S. Henderson. *Archives of Surgery*, XXXV, 419, Sept. 1937.

After a brief survey of the anatomy, with particular attention to the vascular supply of the upper end of the femur, the author discusses the operative treatment for fractures of the neck of the femur incidental to internal fixation. He reports sixteen cases and describes the use of the "lag" screw which is now being used in The Mayo Clinic. It is his feeling that the internal fixation of fractures of the neck of the femur gives better results than the conservative treatment, but that its use must be restricted to patients who can withstand operative shock.—*I. William Nachlas, M.D., Baltimore, Maryland.*

DISLOCATION AND FRACTURE-DISLOCATION OF LOWER CERVICAL VERTEBRAE. James Pierce Cole. *Archives of Surgery*, XXXV, 528, Sept. 1937.

Recognizing the many difficulties that follow the treatment of dislocations and fractures of the lower cervical vertebrae, the author presents a historical survey of this subject and then makes a study of the eighteen patients with this condition seen in the New York Orthopaedic Dispensary and Hospital between 1923 and 1933. His interest is not in the acute type of injury, but in the sequelae resulting from this. It is his feeling that the symptoms persist frequently, even when there has been a closed reduction. The symptoms may be referable to the bony structure, to the spinal cord, and to the nerve roots. If the spinal cord is involved, a laminectomy in conjunction with fusion is recommended; otherwise, fusion of the vertebrae adjacent to the point of injury is found desirable.—*I. William Nachlas, M.D., Baltimore, Maryland.*

EXPERIMENTAL GIANT CELL TUMOR AND CARTILAGINOUS EXOSTOSIS OF BONE. J. Dewey Bisgard. *Archives of Surgery*, XXXV, 854, Nov. 1937.

In the course of experiments on the bones of rabbits, injuries to the epiphyses were accidentally obtained. The repair that took place at these points led to the formation of tumors which had the characteristics of cartilaginous exostoses and, in two instances, of giant-cell tumors. Since the production of these new growths is based upon epiphyseal separation, a condition frequently seen clinically, a careful study of the tumors is made and some deductions are offered in which the experimental masses are compared with the changes which take place in man.—*I. William Nachlas, M.D., Baltimore, Maryland.*

SUI COSIDDETTI "TUMORI GIGANTO-CELLULARI" DELLE OSSA (THE SO-CALLED "GIANT-CELL TUMORS" OF BONE). Filippo Vecchione. *Archivio di Ortopedia*, LII, 547, 1936.

In this monographic presentation of the subject, a very good review of the literature is given, but no original thought is expressed. Vecchione considers the giant-cell tumor of bone as a well-defined nosological entity whose pathogenesis is unknown. He does not believe that bone cysts represent healed giant-cell tumors. It is still questionable whether or not these two forms are in genetic relationship. As far as treatment is concerned, both x-ray and surgical treatment are indicated. The latter ranges from simple curettement with or without caustic fluids to resection, osteoplasty, and amputation. Twelve personal cases are reported.—*Ernst Freund, M.D., Los Angeles, California.*

SUL TRATTAMENTO GLICOCOLLICO DELLA DISTROFIA MUSCOLARE PROGRESSIVA (GLYCOCOLL TREATMENT OF PROGRESSIVE MUSCULAR DYSTROPHY). Antonio Poli. *Archivio di Ortopedia*, LII, 667, 1936.

Poli has treated five cases of progressive muscular dystrophy (Duchenne type) with glycocoll for from three to four months. Only one case showed temporary improvement. In view of his clinical experience and of the studies of the creatine metabolism of these

patients, the author concludes that there is no practical value in glycocoll treatment and apparently no connection between glycocoll and creatine metabolism.—*Ernst Freund, M.D., Los Angeles, California.*

AUTOPLASTICHE OSSEE NELLE PSEUDARTROSI DEL COLLO DEL FEMORE (AUTOPLASTY IN PSEUDARTHROSIS OF THE NECK OF THE FEMUR). Carlo Re. *Archivio di Ortopedia*, LII, 689, 1936.

The author thinks that in the treatment of pseudarthrosis of the neck of the femur one should be very careful in selecting an operative method. In some cases a shelf operation is the method of choice; in others, the transcervical bone graft and subtrochanteric osteotomy are indicated. He has tried these different methods in various cases and has obtained good results.—*Ernst Freund, M.D., Los Angeles, California.*

INFANTILE KYPHOSIS. B. Frejka. *Bratislavské Lekarské Listy*, XVII, 375, Aug. 1937.

One of the causes of round shoulders and defective posture is constant nasal obstruction due to adenoids. The obstruction leads to buccal breathing which is superficial. The thorax becomes more or less fixed in expiration and a thoracic kyphos results with the apex over the sixth, seventh, and eighth vertebrae. This deformity produces subsequently a forward and downward displacement of the head, a depression in the anterosuperior joint of the thorax, and an increase of the lumbar lordosis. Prof. Frejka found this deformity in 80 per cent. of the children with adenoids. In 90 per cent. of the children affected with kyphosis, a nasal examination showed the presence of nasal obstruction, due either to adenoids or to hypertrophy of the mucosa. It ensues that for prophylactic reasons it is important to remove the adenoids in the preschool age and to reestablish the nasal breathing.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE MOVEMENTS OF THE SHOULDER-JOINT: A PLEA FOR THE USE OF THE "PLANE OF THE SCAPULA" AS THE PLANE OF REFERENCE FOR MOVEMENTS OCCURRING AT THE HUMERO-SCAPULAR JOINT. T. B. Johnston. *The British Journal of Surgery*, XXV, 252, Oct. 1937.

The purpose of this article is to explain certain observations made by Martin and Codman in regard to rotation of the humerus during elevation of the humerus in any plane. It is believed that there is less confusion in referring the movements of the humerus in flexion and extension, abduction, and adduction to the plane of the scapula. This is regarded as a plane drawn at right angles to the glenoid cavity through its greatest vertical diameter.

"When the arm is raised to the vertical—no matter what plane or planes it may move through in the process—at the end of the movement the humerus must lie in the plane of the scapula." Full limit of elevation cannot be obtained until the movements of the humerus and scapula bring the two bones into the same plane. The writer does not accept Codman's paradox that the completely elevated arm is in either extreme external rotation or in extreme internal rotation. He offers a group of diagrams to prove that, when the arm is raised to the vertical above the head, the humerus is rotated neither to the medial side nor to the lateral side.

LAMBRINUDI'S OPERATION FOR DROP-FOOT. F. P. Fitzgerald and H. J. Seddon. *The British Journal of Surgery*, XXV, 283, Oct. 1937.

Twenty-four cases in which the Lambrinudi operation has been used are cited. The operation may be used for drop-foot or flail-foot. There have been five failures in the series due to lateral instability at the ankle.

Previous to the operation, the procedure is planned from tracings of lateral roentgenograms with the idea that in certain cases the patient will wear a tapering cork to

build up the back of the foot. Segments of the astragalus, os calcis, cuboid, and scaphoid are removed and the calcaneocuboid joint is cleaned out. The cartilage on the posterior surface of the scaphoid left after removal of a notch is not removed. The cuboid is brought up to the anterior surface of the astragalus and arthrodesed. Likewise the scaphoid is brought upward and forward which brings the forward part of the foot partially or completely up in line. The foot is fixed in a short leg plaster.

WIRBELLUXATION (Dislocation of the Vertebrae). Otto Wenzl. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 53, 1937.

In all cases of dislocation and fracture-dislocation of the vertebrae immediate reposition should be attempted. The author believes that operative treatment gives the best results. He feels that conservative treatment is advisable only in cases of dislocation of the atlas with subsequent operative fixation of the atlas. If the first two cervical vertebrae are wired, healing of the odontoid process can take place. In all other cases immediate operation should be performed, because the marked compression leads to irreparable damages. If the anterior compression is not removed, laminectomy is of no value and the extension treatment is ineffective for the thoracic and lumbar portions. The spinous process and the arch below the dislocation are removed. The luxated vertebra is replaced in its normal position by the use of bone hooks. The prognosis depends upon the amount of damage and the duration of the compression.—*Ernst Bettmann, M.D., New York, N. Y.*

DIE EPIPHYSENLÖSUNG IM SCHENKELHALS BEI JUGENDLICHEN (Separation of the Epiphysis of the Neck of the Femur in the Young). C. Gütig und A. Herzog. *Bruns' Beiträge zur klinischen Chirurgie*, CLXVI, 85, 1937.

In their cases the authors always observed symptoms of endocrine disturbances especially in patients between the ages of ten and seventeen years. There was usually no history of trauma, the lesion being the result of an illness. In one case epiphysiolysis developed during absolute rest. The early symptoms, as shown by the roentgenogram, are: enlargement of the epiphyseal space, rarefaction, zones of calcification in the neck and head, coxa vara, and loss of the head. In the differential diagnosis the following conditions should be considered: tuberculosis, Perthes' disease, and aseptic necrosis of the femoral head. Treatment consists of organotherapy with extension and absence of weight-bearing.—*Ernst Bettmann, M.D., New York, N. Y.*

FRACTURES OF THE FOREARM. George W. Armstrong. *The Canadian Medical Association Journal*, XXXVII, 358, Oct. 1937.

This is a general article dealing with fractures of the forearm. The author gives an outline of the treatment which is generally recognized as proper. He emphasizes the importance of correct reduction, and believes that non-union, when it occurs in cases in which the fractures have been properly reduced, is due to the short period of fixation and to too early movement.—*D. E. Robertson, M.D., Toronto, Canada.*

ANTERIOR POLIOMYELITIS IN ONTARIO. J. T. Phair. *The Canadian Medical Association Journal*, XXXVII, 386, Oct. 1937.

The predicted epidemic of poliomyelitis, in keeping with its cyclic character of visitation, occurred in Ontario in 1937. There were thirteen cases before June 30. During the first two weeks of July, ten cases were reported; during the second two weeks, twenty-eight cases. There was an abrupt rise during August,—fifty-seven cases in the first week, seventy-three in the second, 230 in the third, 336 in the fourth, and 435 to September 4. From July 1 to September 4 there were 1,169 cases reported. (The epidemic continued to about the first of October.)

The incidence is more than ten times as great as for comparative periods in normal epidemic years. In comparison with 1929, when the disease was prevalent in Ontario, there were seven times as many cases up to the end of August. In comparison with 1930, when the most extensive previous outbreak occurred, there were three times as many cases for the corresponding period.

The geographical distribution for the month of August showed 54 per cent. of cases in Toronto and suburban areas.

Thirty per cent. of the cases diagnosed showed muscle weakness or paralysis.

"The Provincial Department of Health has attempted to assist the health authorities and physicians in the affected areas by placing at their disposal the services of specially trained physicians to aid in the diagnosis of doubtful cases. These diagnosticians have been located at convenient centres in those sections in which the disease is most prevalent. Sixteen physicians are engaged in this service. The Department has, further, placed respirators at strategic centres, and is prepared to ensure rapid transportation to those centres of all cases showing evidence of involvement of respiratory muscles. Every effort is being made to ensure the maximum of early orthopaedic treatment in all cases with paralysis."—*D. E. Robertson, M.D., Toronto, Canada.*

Wirbelbrüche und Wirbelverrenkungen; Entstehung und Behandlung der Querfortsatzbrüche. Angeborene Lendenrippen. [Fractures and Dislocations of the Vertebrae; Etiology and Treatment of Fractures of the Transverse Processes. Congenital Lumbar Ribs.] L. Böhler. *Der Chirurg*, VIII, 121, 1936.

The author emphasizes the importance of the differential diagnosis in cases of congenital lumbar ribs. The presence of gas bubbles proximal to this process should be taken into account. The margin of the psoas muscle, kidney stones, and epiphyseal spaces may obscure the diagnosis. The transverse processes play no part in the supporting function of the spine, and, for that reason, in the treatment the application of support by braces is not advisable. An operation is preferable when there is evidence of rupture of the soft tissues.—*Ernst Bettmann, M.D., New York, N. Y.*

Old Dislocation of the Hip Joint with Fracture of the Acetabulum. A. Gruca. *Chirurgja Narzadow Ruchu i Ortopedja Polska*, X, 79, 1937.

The author reviews Campbell's work on posterior dislocation of the hip with fracture of the acetabulum and describes a complicated case of dislocation of the hip joint accompanied by a multiple fracture of the acetabulum. Examination of the patient two months after the accident showed a consolidated malunion of the acetabulum, paralysis of the sciatic nerve, posterior dislocation of the femoral head, and considerable impairment of function. The patient was operated upon. The acetabulum was reestablished; the posterior fragment of the fractured acetabulum was fixed in its proper place by a nail; the head was placed back into the acetabulum; and the neoplastic periarticular bone tissue was removed. Reexamination of the patient one year after operation showed absence of pain, limp, and shortening, almost normal flexion, extension and abduction of the thigh, and some restriction of adduction of the thigh and of dorsiflexion of the foot.—*Emanuel Kaplan, M.D., New York, N. Y.*

La Desarticulación Inter-Ilio-Sacro-Púbica. Dario Fernandez Fierro. *Cirugía y Cirujanos*, V, 169, 1937.

The author reports an interiliosacropubic disarticulation which he performed successfully on June 11, 1936, on a woman with a metastatic tumor of the ilium. From the location and character of the tumor, he believed that only this type of operation or that of Billroth-Jaboulay could save the patient's life. After a thorough review of the literature on this subject, consultation with his staff, and study of cadavera, the following technique was perfected.

An incision, two centimeters above the symphysis pubis and running parallel to Poupart's line and the crest of the ilium up to and level with the spine of the ilium, is made. From the anterior superior spine of the ilium another incision is made in the direction of the greater trochanter, through the gluteal furrow and the genitocrural furrow up to the point where the incision began.

The soft parts are then divided their full length following the line of the first incision, including the cellular tissue, the aponeurosis, the obliquus externus abdominis, the obliquus internus abdominis, and the transversus abdominis up to the preperitoneal cellular tissue. Great care should be taken to protect and isolate the spermatic cord in the male and the round ligament in the female. The psoas muscle is isolated and its superior portion is sectioned, and the femorocutaneous and genitocrural nerves are cut. The crural and the obturator nerves are next sectioned, a novocain solution having been previously injected. The common iliac artery and vein are then ligated temporarily or permanently if the ligation of the external iliac artery and the branches of the internal iliac artery can be done as they are being sectioned off. The external iliac artery is ligated at its extreme distal end, as was done with the obturator, to prevent the seeping of blood from the extremity as it is handled. The dissection of the peritoneum is continued anterior and posterior to the pelvic cavity, so that the region of the symphysis pubis may be completely uncovered and the bladder, the intestinal mass, and the ureter may be pushed back. The gluteus maximus is next divided, followed by division of the gluteus medius, gluteus minimus, and the piriformis to a point on a level with the greater trochanter; this is accomplished by rounding with the scalpel the superior, anterior, and posterior borders of the trochanter.

An incision, the full length of the crest of the ilium and a little below it, is made, so that the gluteal muscles may be detached along the full length of the external aspect of the ilium, the border of the sacrum, the coccyx, and the external surface of the greater sacrosciatic ligament. During this step, the gluteal and ischiatic vessels are ligated and, at this time, the decision as to whether or not to untie the ligatures of the common iliac artery and vein may be made. The dissection of the fold is continued and, at the level of the greater sciatic notch, the gluteal and greater sciatic vessels are divided. The sciatic nerve is sectioned off, a solution of novocain having been previously injected.

The dissected area is explored very carefully to make sure that the symphysis pubis is completely free. If the patient is a male, care should be taken to push back the spermatic cord, the penis, and the testicles; if a female, the same procedure should be followed with the round ligament. If this ligament has been cut, it should be fixed to the aponeurosis of the rectus, as is done when dealing with an inguinal hernia. The symphysis pubis is divided; the iliacus is separated; and the dissection is continued, keeping as close as possible to the descending ramus of the pubis. Hemorrhage can be controlled by compression. Finally, a point is reached at which the iliac bones cannot be separated further, and the dissection is carried through the posterior part of the pelvis to the sacro-iliac synchondrosis, and the iliacus is divided. After ligation of a few of the iliolumbar vessels, the disarticulation is begun, starting posteriorly. By so doing, the articular interline can be located, which permits a little more separation of the iliac bones. The final step consists of the division of the remaining soft tissues and the sacro-iliac and sacrosciatic ligaments. After this has been done, the extremity is detached, leaving a thick and well-nourished fold. The muscles of the fleshy fold are nourished by the muscles of the abdominal wall and the skin. A drain is left at the center of the fold.—*Carlos Finck, M.D., Torreon, Coah., Mexico.*

DIE PERIARTHRITIS HUMEROSCAPULARIS (Humeroscapular Periarthritis). Hans Schaer. *Ergebnisse der Chirurgie und Orthopädie*, XXIX, 211, 1936.

This complicated clinical picture, first described in 1872, is thoroughly analyzed and revised by the author. The affection presents various pathological changes. The following conditions are described: (1) post-traumatic stiffness, (2) lesions of the supra-

spinatus tendon (rupture, etc.), (3) bursitis, (4) apophysitis, and (5) arthrosis of the intertubercular sulcus and acromioclavicular arthritis. The author emphasizes the diagnostic importance of local tenderness above the following points: tuberculum majus, tuberculum minus, sulcus bicipitalis, processus coracoideus scapulae, and the acromioclavicular joint. Trauma to the supraspinatus tendon causes tenderness two inches outside the acromion in the center of the deltoid muscle. The Bettmann shoulder-ridge symptom (shortened neck and shoulder line, elevated shoulder) and atrophy of the supraspinatus and the infraspinatus muscles are often present. The painful locking in abduction between 60 and 100 degrees and painful rotation are pathognomonic. The rupture of the supraspinatus tendon is often due to degenerative changes associated with calcareous pseudobursitis. The existence of calcification is usually the result of an accident. The author often advises the application of a plaster-of-Paris cast. Radiation and novocain anaesthesia are also recommended.—*Ernst Bettmann, M.D., New York, N. Y.*

Die entzündlichen Erkrankungen der Kniescheibe (Inflammatory Diseases of the Patella). C. Blumensaat. *Ergebnisse der Chirurgie und Orthopädie,* XXIX, 310, 1936.

The following inflammatory diseases of the patella have been observed by the author: osteomyelitis (which is usually secondary), bursitis, tuberculosis, and lues. In osteomyelitis the change is due to the slower circulation and larger blood supply in the apophysis of the patella. The treatment consists of curettage, if total resection is not necessary. The tuberculous changes are accompanied with effusion, as is also bursitis, which, in contrast to osteomyelitis, is confined to the patella only. Early operation is recommended. The very rare lues of the patella is characterized by severe pain at night and marked periostitis. Tabetic changes are rather frequent and show marked atrophy.—*Ernst Bettmann, M.D., New York, N. Y.*

Die Tumoren der Kniescheibe (Tumors of the Patella). C. Blumensaat. *Ergebnisse der Chirurgie und Orthopädie,* XXIX, 347, 1936.

The most frequent tumors are osteomata and chondromata, with enlargement and shifting of the patella. Resection is recommended. Sarcomata, as periosteal and central tumors, grow rather slowly and in every case biopsy should be done. Myelomatous and carcinomatous metastases are rare and can be mistaken for osteitis fibrosa with giant cells.—*Ernst Bettmann, M.D., New York, N. Y.*

End Results in Fractures of the Shaft of the Femur. Eldridge L. Eliason and John Paul North. *Journal of the American Medical Association,* CIX, 848, Sept. 11, 1937.

The writers report seventy-four fractures of the femoral shaft treated by various methods. They advocate conservative treatment based upon the fundamental principles of fracture treatment.

In discussing different methods of traction, they point out that the one best suited to the individual case should be selected and that it must be continued uninterruptedly until firm union occurs. In their opinion, skeletal traction is next to operative reduction in efficiency. Russell traction is only fairly satisfactory and should be discarded for another method if good alignment is not obtained in a few days. In muscular patients with definite shortening, skin traction should not be employed. In small children, however, vertical suspension of both legs with the hips flexed to 90 degrees is considered the most effective.

Plaster-spica fixation may be used with caution in cases without displacement and in those in which callus holds the fragments together. Fresh fractures are apt to slip in

the plaster fixation, and this should be watched for with frequent x-rays. Also, permanent damage may be done to the knee joint by long immobilization.

Surgery should be used as the last resort and in the authors' series the results did not justify the procedure.

The authors conclude that emphasis should be placed on restitution of function, and that perfect anatomical reduction is not essential. Skin traction on the thigh is least effective, it being satisfactory in only 11 per cent. of the cases in which it was used. Skeletal traction was adequate in 62 per cent. Perfect results were obtained in over 90 per cent. of the children in this series, whereas only 64 per cent. of the adults escaped without permanent disability.—*W. B. Carrell, M.D., Dallas, Texas.*

HYPERTROPHY OF THE LIGAMENTA FLAVA AS A CAUSE OF LOW BACK PAIN. R. Glen Spurling, Frank H. Mayfield, and James B. Rogers. *Journal of the American Medical Association*, CIX, 928, Sept. 18, 1937.

The authors believe that low-back pain, associated with objective sensory and motor neurological changes, is caused by an intraspinal lesion. They point out that the hyperplasia of the ligamenta flava as such a lesion is not generally recognized. The report is based on seven operated cases with this pathological finding. In six of them the lamina of the fourth lumbar vertebra was increased in thickness which might have been a part of the causative factor.

In each case the patient gave a history of trauma, radiating pain down one or both legs, and discomfort not relieved by recumbency. In four of the seven patients there was objective motor loss, two of them having definite atrophy. For diagnosis an adequate neurological examination is essential to differentiate between an extraspinal and an intraspinal lesion. If the total protein of the spinal fluid is elevated, a subarachnoid injection of two cubic centimeters of iodized oil is indicated. In the six cases in which this was done, a characteristic filling defect was shown opposite the fourth lumbar interspace. In order to obtain sufficient exposure, the laminae above and below the lesion were removed. The ligamenta flava showed marked hypertrophy with some areas of calcification. Microscopic examination showed a marked amount of cicatricial tissue. No signs of old or recent infection were present. To find the normal thickness of the lamina of the fourth lumbar vertebra, ninety-three spines were measured, and the lamina of the fourth was found to be about the same size as that of the third and fifth. The ligamenta flava in the lumbar areas of forty cadavera examined were found not to be hypertrophied at the fourth lumbar interval.

With the exception of one fatality from streptococcic meningitis, the results were excellent. Sensory and motor disturbances rapidly returned to normal. Three impotent patients recovered in from one to five days. Three returned to hard labor in six weeks. The writers conclude that this ligamentous hypertrophy was due to trauma. In the process of healing, or as a result of continuous trauma, an excess of scar tissue formed.—*H. M. Childress, M.D., Dallas, Texas.*

MALUNITED COLLES' FRACTURES. Willis C. Campbell. *Journal of the American Medical Association*, CIX, 1105, Oct. 2, 1937.

Presented in this paper is a surgical procedure for the restoration of anatomical alignment and the function of a wrist disabled by an old Colles' fracture unsuccessfully treated. In the author's opinion, malunion is due to one or more of the following: failure to obtain proper reduction; recurrence of deformity after apparent reduction; excessive comminution with radial shortening; complete rupture of the radio-ulnar ligament with undue mobility of the distal ulna; too early physiotherapy before firm union develops.

In describing this deformity, the author stresses in particular the radial deviation and the widening of the wrist. Simple osteotomy of the radius may aid in promoting function, but it does not correct the abnormal contour either of the radius or of the ulna. His

plastic operation restores the normal angle of the radial articular surface, corrects the radial shortening, and produces a normal contour of the ulna. This is accomplished by a transverse osteotomy of the radius about one inch above the wrist. The medial portion of the distal one inch of the ulna is removed and is used as a bone wedge between the fragments of the radius. This is placed in such a manner that its widest portion lies dorsally and laterally thereby correcting both the radial deviation of the hand and the radial articular angle. The discus articularis is anchored subperiosteally or to the bone by means of a drill hole through the ulna.

Results in nineteen cases have been uniformly good. Of these, eleven known end results are excellent. In one other case the result was not satisfactory, as excess mobility of the distal ulna was present. This was due to a ruptured interarticular fibrocartilage. Advantages claimed by the author are the restoration of practically normal function and the correction of an unsightly deformity.—*W. B. Carrell, M.D., Dallas, Texas.*

THE CARE OF THE FEET IN CHRONIC ARTHRITIS. John G. Kuhns. *Journal of the American Medical Association*, CIX, 1108, Oct. 2, 1937.

According to Kuhns, the joints most frequently affected by chronic arthritis are those of the hands and the feet, but more attention is given to rehabilitation of the hands. Much, if not all, of the pain and deformity can be avoided by early and adequate treatment. He outlines the general measures used in treating over 1200 patients with this condition.

The only certain method of preventing late disability is by the avoidance of weight-bearing until the pain and swelling have subsided. Heat and immobilization may also be necessary at first, followed by graduated exercises. Finally, proper shoes with supports and correct posture are essential.

The most common condition of an untreated case is a foot rigid in valgus. Because weight-bearing is faulty, strains at the knee and hip are produced. There is atrophy of the intrinsic musculature and a subsequent flattening of the anterior arch. This is followed by pressure on the metatarsal heads, with resultant pain. This deformity further aggravates the inflammatory condition of the joints. Forceful correction under anaesthesia may be necessary in the late stages. Among late complications of chronic arthritis, the author mentions hallux valgus, contracted-toe deformity, ankylosis of the small joints, and spur formation on the tarsal bones. The latter is due in most instances to a chronic strain rather than to infection. Another disability of the arthritic foot is epidermomycosis. The impaired circulation of the foot causes this extremity to become frequently affected.

Both local and systemic treatments are indicated in caring for the feet of arthritic patients. Early and adequate measures will prevent painful complications and deformities. Good body alignment is also essential to ensure permanent cures.—*H. M. Childress, M.D., Dallas, Texas.*

FOOT DISORDERS IN GENERAL PRACTICE. Dudley J. Morton. *Journal of the American Medical Association*, CIX, 1112, Oct. 2, 1937.

The writer is critical of the view that most foot disorders are due to faulty shoes or to weakened musculature of the feet. In discussing the anatomy and the functioning of the foot, he states that the first metatarsal is of the greatest functional importance. In standing, it supports twice the load held up by the other metatarsals, and in motion it alone, with its associated muscles, sustains half of the greatly increased stress placed upon the foot. When there is a functional deficiency, as in a pronated unbalanced posture, the stresses are concentrated on the second metatarsal which soon shows hypertrophy. This pronation is due to a failure of the first metatarsal to carry its burden; there is a shift of weight medially; and a progressive condition is started which ends in a rigid flat foot.

In his estimation, most foot disorders are primarily due to a functional deficiency of the first metatarsal segment. Secondary changes are traumatic arthritis and strain upon ligaments of the long arch. There may be accompanying vasomotor changes in the foot, areas of numbness, and even radiating pain up the legs. Treatment consists of local applications to superficial irritation, rest and physiotherapy for the deep trauma and the inflammatory changes, and a correction of the disordered mechanics by changing the patient's shoes as indicated.—*H. M. Childress, M.D., Dallas, Texas.*

PAIN LOW IN THE BACK AND "SCIATICA" DUE TO LESIONS OF THE INTERVERTEBRAL DISCS. J. S. Barr, A. O. Hampton, and W. J. Mixter. *Journal of the American Medical Association*, CIX, 1265, Oct. 16, 1937.

Ruptures of the intervertebral discs are not rare according to the authors who report fifty-eight operated cases. Such pathology usually is found in healthy vigorous men from twenty to fifty years of age. A history of trauma was found in 80 per cent. of the authors' cases. Pressure upon one or more roots of the cauda equina produces signs and symptoms similar to those found in sacrolumbar and sacro-iliac strains with "sciatica". The most characteristic sign is a limitation of lumbar motion by muscle spasm. A list, to or from the affected side, is frequent. Neurological findings may be normal in about 50 per cent. of the patients. The most common positive neural sign is an absent or diminished knee jerk.

Roentgenographic examination revealed significant variations in but one-half of the cases. Schmorl's nodule was observed occasionally, but had no definite relationship to the condition discussed. Low lumbar puncture should be done in all suspected cases. Fifty-two patients of this series had a total protein of over forty milligrams per 100 cubic centimeters. If the spinal-fluid total protein is high, the diagnostic use of iodized oil is indicated. The lesions may be accurately localized with the oil injection. It must be controlled along the anterior and lateral surfaces of the canal, as this is where the pathology is found. No damage was produced by the use of this oil in any case. Serial x-rays of the oil in the canal are essential. The filling defects must be correctly interpreted. If no such defect is shown in the anteroposterior roentgenogram, the test is considered negative for evidence of a ruptured disc. Rupture of the fifth lumbar disc is difficult to demonstrate, and it is better to reexamine the patient two weeks after the injection. At this time the nerve sheaths and the lateral portion of the canal will be well outlined.

In thirty-two of the operated cases studied complete relief was obtained; in twelve improvement was noted; only two were classed as failures. The writers believe that no accurate clinical diagnosis of low-back pain with "sciatica" is possible without roentgenographic examination. Iodized oil should be used when conservative treatment is unsuccessful. The operative mortality is low, the percentage of cures high.—*H. M. Childress, M.D., Dallas, Texas.*

LOCAL OVERGROWTH. Fremont A. Chandler. *Journal of the American Medical Association*, CIX, 1411, Oct. 30, 1937.

The author believes that defective growth may be due to deficiency of germ plasm, circulatory failures occurring in early embryonic life, or epiphyseal disturbances. One or more of these factors may produce an overgrowth or an arrest of growth, locally or generally. Unilateral arrest of growth is treated successfully by shortening the well extremity. Bilateral arrest of growth, however, brings up the question of treatment with endocrine products and vitamin therapy.

Overgrowth is due to an epiphyseal stimulation which, in turn, is caused by an increase in the epiphyseal blood supply. Trauma, infection, foreign materials, and some chemicals at or near the epiphysis are the usual inciting factors. Arteriovenous fistulae and lymphatic obstruction by parasites may cause overgrowth, provided the condition occurs during the period of growth. Endocrine imbalances may be somewhat selective,

but, in general, local overgrowth is uncommon. Disturbed growth hormones may cause local hypertrophy, but the reasons for this are not known.

The writer points out that little is known of the causes for this upset in symmetrical growth and that such an undeveloped field should arouse the interest of research workers.—*W. B. Carrell, M.D., Dallas, Texas.*

THE PRACTICAL APPLICATION OF PHYSIOLOGICAL PRINCIPLES IN TREATMENT OF FRACTURES. Willis C. Campbell. *Khirurgiya*, I, 72, 1937.

The biology of the healing of fractures is reviewed, and basic principles of treatment are outlined. The routine treatment is summarized as follows:

1. Good reduction from inspection of the external contour checked by the roentgenogram.
2. Roentgenographic confirmation of reduction without removal of splints at the end of one week.
3. Removal of immobilization while callus is malleable, roentgenographic check-up, and correction of any angulation.
4. In certain fractures, continued protection for an indefinite period until absolute consolidation can be shown by roentgenographic and clinical examinations.—*Emanuel Kaplan, M.D., New York, N. Y.*

PATHOGENESIS AND THERAPY OF KÖNIG'S OSTEOCHONDRITIS IN CONNECTION WITH TWO CASES. M. Z. Rotenfeld. *Khirurgiya*, I, 93, 1937.

A description of a rare localization of osteochondritis is given. In two cases the process involved the lateral condyle of the femur, and in one case, the head and neck of the radius. The pathological diagnosis is differentiated from other processes in this area. The treatment consisted of iron and potassium-iodide therapy, with satisfactory results as far as function of the joints was concerned.—*Emanuel Kaplan, M.D., New York, N. Y.*

REDUCTION OF POSTERIOR DISLOCATIONS OF THE FOREARM. B. A. Peskin. *Khirurgiya*, I, 97, 1937.

The author reviews the known methods of reduction and describes his own. The patient is placed on a chair sidewise, with a folded towel under the arm pit of the injured limb to protect it from the back of the chair. The surgeon places his knee on the volar surface of the forearm near the elbow joint and produces downward pressure while the distal end of the forearm is first being supported and then slowly flexed by his hand. This method produces less trauma to the articular surfaces and does not require the application of great force.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE TECHNIQUE OF REDUCTION OF SHOULDER-JOINT DISLOCATIONS. A. A. Kudryavtsev. *Khirurgiya*, II, 164, 1937.

A new method of reduction is described. The patient is placed horizontally, lying on the undislocated side with the arm stretched out along the body and the hand completely pronated to prevent him from lifting his body up while the actual reduction takes place. A cuff is attached to the wrist of the dislocated arm and by means of a cord is pulled up and fixed above in such a manner that the trunk of the patient is lifted slightly from the horizontal plane and the dislocated arm, abducted by the pull, forms an angle of about 110 degrees with the chest of the patient. To overcome the resistance of the muscles, the usual amount of morphine sulphate is injected before the reduction. It is claimed that reduction takes place in from one to five minutes, and is successful in cases where other methods fail.—*Emanuel Kaplan, M.D., New York, N. Y.*

SOME PHYSIOLOGICAL ASPECTS OF NATURAL AND ARTIFICIAL SUNLIGHT. F. S. Cooksey. *The Medical Press and Circular*, CXCIV, Supplement, i, 1937.

It is generally accepted that artificial sunlight for therapeutic purposes refers only to the ultra-violet rays, and only these rays are considered in this article. The rays adjacent to the visible spectrum are referred to as the long, near, or biotic rays (3900 A. to 2900 A., *A* representing the Angström unit of wave-length) and the remainder as the short, far, or abiotic rays (2900 A. to 1800 A.). The long rays are stimulating to animal and vegetable protoplasm, while the short rays are destructive.

The abiotic rays may be used therapeutically to sterilize the skin in acne and multiple furuncles, the surface of indolent wounds and ulcers, and the conjunctival sac as a preliminary to ophthalmic operations, etc. They do not penetrate below the stratum corneum of the skin and will be almost completely absorbed by the air if the patient is more than two feet away from the radiating source. The abiotic rays are not present in the natural sunlight at the earth's surface, being absorbed by the atmosphere.

The erythema reaction to the biotic rays varies with the amount and character of ultra-violet rays absorbed, and is most pronounced with rays of about 2970 A. The first-degree erythema causes only a brief slight flushing of the skin and no discomfort. In the second degree the skin is a bright pink, there is some irritation, and fine peeling and pigmentation follow in a few days. In the third degree there is intense redness with much discomfort lasting some days and followed by coarse peeling and deep pigmentation which may persist for many months. The fourth-degree reaction is a blister, followed by scarring.

The first-degree and second-degree reactions provoke a cutaneous vasodilatation which may last forty-eight hours. They effect an acceleration of the functions of the skin, and secretion of sweat and sebaceous glands and excretion of urea are increased.

It may be said that exposure to sunlight raises the subnormal but does not affect the normal physiological activity of the skin. Patients with low vitality following debilitating illnesses respond well to sunlight. Much of the value of sunlight lies in the fact that the cutaneous stimulus is sustained, while it fades with the cessation of other treatments such as heat, cold baths, exercise, etc. Pigmentation varies with the degree of erythema produced. The pigment absorbs ultra-violet rays and converts the energy into heat. As the pigment deepens, a longer exposure becomes necessary to produce the same reactions. The function of the pigment is to protect the body against excessive exposure to sunlight; if several weeks are allowed to pass without exposure, a smaller dose is required although pigmentation persists.

Activated by the ultra-violet rays, ergosterol is converted in the skin into vitamin D; the antirachitic rays are sharply defined about 2980 A. Sunlight prevents and cures rickets by supplying the necessary vitamin for the regulation of the calcium and phosphorus metabolism of bone.

Ultra-violet rays have a stimulating action coincident with the onset of erythema and a late sedative action an hour or so later. Drowsiness is commonly experienced during irradiation. If the dose has been excessive, the absorption of breakdown products, following wide-spread destruction of epidermal cells, gives rise to general malaise, nausea, and headache, and later to soreness of skin, mental irritation, and restlessness.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE "NATURE" OF RHEUMATISM. F. J. Poynton. *The Medical Press and Circular*, CXCIV, 416, 1937.

After forty years of intense work and study on rheumatic disease, the infection theory still holds the most prominent place, although the exact nature of the infection and its mode of action are still warmly contested.

Investigations based upon the streptococcal-infection theory have taught us the meaning of the local focus, and, with micrococci obtained from these foci and rheumatic

lesions, carditis, nodule formation, and multiple arthritis have been experimentally produced in animals.

Poynton and Paine originally explained rheumatism as a generalized secondary infection of the joints, heart valves, fascia, etc., coming from an original focus, the tonsils, just as a general infection producing multiple abscesses may originate from some primary purulent focus. However, just how this infection travels from the primary focus to the secondary locations is not explained nor understood.

The objections to the infection theories are based upon the fact that very seldom are streptococci found in the secondary lesions or in the blood stream, although they may be found in the primary lesion. This fact leads many workers to hold to the allergic theory. This theory pictures a local focus pouring into the body streptococcal poison or antigen. This antigen in the circulation stimulates the reticulo-endothelial cells to produce a specific antibody. If the production of antibody is good, the antigen is neutralized in the circulation and no harm is done to the body cells. However, if the antibody response is poor, the antigen combines with the antibody in the cells and produces cell destruction.

Studies in regard to the virus theory are still in the infantile stage, since highly specialized investigations are required and the accuracy of these studies depends on the skill of the laboratory investigators.

Rheumatism in adult life may be complicated by glandular dysfunction, climatic conditions, habits, occupation, injuries, etc. All or nearly all the glands have been incriminated, but the view now most supported is that two or more of them acting together are responsible.

The rôle of metabolic disturbances in rheumatism is uncertain. A patient who overeats and underexercises may develop a gouty tendency and thus be below normal in his ability to resist infections, but, outside of this observation, little else can be definitely stated in regard to the relationship of metabolic disturbances to rheumatism.

Injury and degeneration of the articular structures may play a part in old-age arthritis. In old age there is a diminished blood supply to the joints, with the result that the cartilages become thin and split and the exposed bone is worn down and roughened.

Fibrositis is an aspect of rheumatic involvement. Infectious (apparently) nodules form in fascia and tendon sheaths. These may come on slowly and last a long time. The ordinary stiff neck or "crick" in the neck gives symptoms similar to the rheumatic involvement of the same structures, yet it surely cannot be an infection developed in those muscles overnight. This leads us to consider the reaction of nerve endings and skin circulation to the system in general. These may also be factors in the onset of rheumatism.—*Herbert E. Hipps, M.D., Marlin, Texas.*

Chronic Rheumatic Arthritis. H. Warren Crowe. *The Medical Press and Circular*, CXCIV, 426, 1937.

By the term "chronic rheumatic arthritis" the author means the residue of joint disease which is left after exclusion of acute joint disease, an injured joint, a specific arthritis, and gout.

The author discusses the symptoms, physical findings, and differential characteristics of rheumatoid arthritis and osteo-arthritis. His opinion is that the former is infectious in origin and the latter is degenerative, although there may be a mixing of the two types chiefly in older individuals.

Treatment of rheumatism consists of (1) prevention of deformity, (2) correction of existing deformities, (3) postural training, (4) physical therapeutic methods to increase muscle tone and to reduce pain and inflammation, (5) rest, and (6) vaccines.

As a rule, drugs have been unsuccessful, although aspirin and other sedatives are valuable.

Focal infection should always be kept in mind.

The author goes into detail in explaining how vaccines should be given. If a patient has any kind of a reaction following an injection, the dose should be decreased materially.

Rest is itself an extremely important part of the treatment of such a condition.

Recalcification of the bone, improvement in the blood picture, and gain in weight and general health are important signs of recovery, and they sometimes occur before pain reduction. Proper attention to all these details over a long period of time is necessary before a cure can be obtained.—*Herbert E. Hipps, M.D., Marlin, Texas.*

HALLUX VALGUS: STUDY OF END RESULTS OF 339 BUNIONECTOMIES. W. R. Hamsa. *Nebraska State Medical Journal*, XXII, 225, 1937.

Dr. Hamsa presents a splendid and timely paper on the subject of hallux valgus. There is so much conflicting information on the subject in medical literature, and so many different methods of operative repair are described by various authors, that to the average practitioner the subject presents a picture of the wildest confusion. Dr. Hamsa has very carefully compiled a table of all the various procedures used in the treatment of this condition, and has made a careful study of the etiological factors involved.

He states that in the Orthopaedic Department at the University of Iowa there have been performed 339 operative corrections with a postoperative follow-up ranging from two months to a maximum of twenty-two years. As the McBride and Brandes techniques have only been used for the past four years, the series for these particular operations is quite small. The following is an abstract of a table presented by the author: The simple Silver osteoplasty produced good results in 79 per cent.; excluding the arthritics, good results were obtained in 87 per cent. The Mayo osteoplasty gave good results in 91 per cent.; with arthritics excluded, 92 per cent. With McBride and Brandes osteoplasties good results were obtained in 86 and 67 per cent.

In conclusion the author states that congenital anomalies play only a minor rôle in the production of hallux valgus. Extrinsic forces (improper shoes, etc.) contribute directly in most cases to the formation and the recurrence of hallux valgus. Conservative treatment improves many early cases. Simple correction of the exostosis without correction of the deviation (if not over 15 to 20 degrees) is the most logical treatment in women who wish to wear dress shoes. In the absence of arthritic changes the Silver and McBride operations are the best. Where arthritic changes are present, the Mayo osteoplasty is apparently the best. Associated small toe deformities should be corrected. Metatarsus primus varus of from 15 to 20 degrees should be corrected along with the hallux valgus, base correction being more logical and affording better results than shaft osteotomy.—*William R. Malony, Jr., M.D., Iowa City, Iowa.*

PNEUMOROENTGENOGRAPHY IN THE DIAGNOSIS OF THE LESIONS OF THE KNEE JOINT. A. Lachowicz and M. M. Goldman. *Polski Przeglad Radjologiczny*, X and XI, 35, 1936.

The authors use an improved technique of pneumoroentgenography and present a series of excellent x-rays demonstrating the possibility of diagnosis in cases of injury to the menisci, in Hoffa's disease, in cases of intra-articular free bodies, and in inflammatory conditions of the synovia. They also mention the diagnostic possibilities in osteochondritis dissecans and chondropathy of the patella.—*Emanuel Kaplan, M.D., New York, N. Y.*

OSTEOMYELITIC INVOLVEMENT OF THE SHOULDER AND HIP JOINT. M. Schieber. *Polski Przeglad Radjologiczny*, X and XI, 92, 1936.

In a personal investigation of several cases, the author found characteristic changes in osteomyelitis of the hip and shoulder. There are early small foci of decalcification sometimes revealing the presence of minute sequestra and a very mild periosteal reaction. If the process begins in the acetabulum, small excavations filled with sequestra appear. The roof of the acetabulum usually remains intact, the most frequent complication being the separation of the epiphysis, followed by destruction and dislocation. Similar changes were observed in the shoulder joint.—*Emanuel Kaplan, M.D., New York, N. Y.*

DES RAIDEURS ARTICULAIRES APRÈS LES BUTÉES OSTÉOPLASTIQUES DE HANCHE (ARTHROPATHIES POST-OPÉRATOIRES). [Articular Stiffness after Osteoplastic Shelf Operations on the Hip (Postoperative Arthropathies).] Tavernier et Albert Trillat. *La Presse Médicale*, XLV, 1051, 1937.

The articular pain which is so common in hips about which osteoplastic shelves have been turned down constitutes a special category of postoperative arthroses. They appear invariably in patients past the age of five, in whom the femoral head has been forcibly brought down to the level of the acetabulum and the shelf acts as an efficient block to dislocation. The condition is characterized by a true articular stiffness, which frequently does not yield even under anaesthesia. Pain is not present and deformities do not develop.

The x-ray shows osteoporosis, without narrowing of the joint outline. For a period of about three years the stiffness persists; then gradually the mobility present before operation returns. During this time the bone undergoes a gradual osteoporosis for a period of about two years and then gradually recalcifies.

The authors attribute the condition to capsular tissues. They consequently recommend that no effort be made to pull the femoral head down in those cases in which a shelf operation is contemplated. They further caution against any hasty arthroplastic procedures in these cases of postoperative arthroses.—*Henry Milch, M.D., New York, N. Y.*

L'ÉTIOLOGIE DU TORTICOLIS MUSCULAIRE (The Etiology of Muscular Torticollis). Werner Schmid. *La Presse Médicale*, XLV, 1189, 1937.

The opinion is expressed that the origin of torticollis is to be sought, not in the mother, but in the foetal structures. The muscular ischaemia is brought about first by a perifoetal cause, oligohydramnios, due to abnormality of the foetal membranes; and second by an endofoetal cause, a failure of normal differentiation of the mesenchyme. A genealogical table is added. The author is of the opinion that "torticollis is a hereditary disease, recessive in the genotype and probably bihybrid".—*Henry Milch, M.D., New York, N. Y.*

QUAND ET COMMENT PRATIQUER LA VACCINATION PAR LE BCG (When Should Vaccination with BCG Be Undertaken)? Jean Paraf et Boissonet. *La Presse Médicale*, XLV, 1307, 1937.

The authors insist upon the value of vaccination against tuberculosis by means of Calmette's BCG. They note that the vaccine has not proved of much value in those children who are subject to repeated massive infection from parental sources. On the other hand, if the children are removed from these contacts and are subject to only casual infection, the method has proved definitely valuable. In such cases the vaccination need not be undertaken before the age of six.—*Henry Milch, M.D., New York, N. Y.*

REFLEXION SUR LE SYNDROME D'EMBOLIE ARTÉRIELLE DES MEMBRES (The Syndrome of Arterial Embolism of the Extremities). Marc Iselin et R. Heim de Balsac. *La Presse Médicale*, XLV, 1373, 1937.

The authors performed arteriotomy for thrombosis in four patients. Three of these patients died and careful post-mortem examinations were possible. The authors draw the following conclusions:

1. In cases which are clinically typical of embolism, the punitive phenomenon is that of loss of arterial pulsation. This segmental arterial paralysis can be explained only on a regional nerve basis.

2. The clot forms secondary to the cessation of arterial pulsation.

3. The arterial-trunk circulation and circulation to the extremities are entirely independent of each other.

4. Arterial paralysis is a consequence of arterial-trunk injury.

This fundamental conception forms the basis for arteriectomy, as practised in these cases. Either arteriectomy or arteriotomy for embolectomy may release the arterial paralysis and so prevent gangrene.—*Henry Milch, M.D., New York, N. Y.*

PIED BOT ET HÉMIPLÉGIE FRUSTE (Club-Foot and Unsuspected Hemiplegia). André Thomas. *La Presse Médicale*, XLV, 1333, 1937.

Attention is called to the fact that club-foot may be due to an unsuspected hemiplegia. This may be brought to light by careful examination of the tonicity of the muscles, by the response to stimulation, by the voluntary or involuntary motility of the involved extremity, etc. In the very mild cases these observations may be made, even in the absence of any reflex signs of pyramidal-tract involvement.—*Henry Milch, M.D., New York, N. Y.*

CONSIDÉRATIONS SUR LES RHEUMATISMES ET LEUR TRAITEMENT (Rheumatism and Its Treatment). J. Le Calvé. *La Presse Médicale*, XLV, 1409, 1937.

The author has treated 155 cases of all types of "rheumatism" on the basis of a sulphur deficiency, associated with a hypovitaminosis. These include twenty-four cases of sciatica, acute articular rheumatism, psoriatic arthropathy, chronic rheumatism, acute infectious rheumatism, etc. The percentage of satisfactory results is not given.

The treatment consists of a diet rich in vitamins, sulphur injections, and autohemotherapy,—twenty cubic centimeters every four to five days.—*Henry Milch, M.D., New York, N. Y.*

OSTÉOSES ET PÉRIOSTÉOSES PAR CARENCE ALIMENTAIRE CHRONIQUE (Osteosis and Periosteosis Due to Chronic Alimentary Deficiency). G. Mouriquand, H. Tete, et P. Viennois. *La Presse Médicale*, XLV, 1419, 1937.

In an earlier work the authors showed that it was possible experimentally to reproduce the syndrome of chronic rheumatism by dietary deficiency. In the present essay they show that, in contrast to animals submitted to a total scorbutic diet, animals which were given diets only partially deficient in vitamin C preserved a state of relative eutrophia. They developed the typical osseous tumefactions due to subperiosteal hemorrhages. If treated within the first twenty-five days, these tumefactions disappeared. If the experiment was persisted in longer, the tumefactions gradually ossified and were associated with articular stiffness, clinically resembling an ankylosing arthritis.—*Henry Milch, M.D., New York, N. Y.*

THE VALUE OF THE OBLIQUE VIEW IN THE RADIOGRAPHIC EXAMINATION OF THE LUMBAR SPINE. S. A. Morton. *Radiology*, XXIX, 568, Nov. 1937.

This projection, called the Dittmar position, is made as follows: The patient is placed on a flat Bucky table, with the legs extended, and is raised 45 degrees toward the side to be examined,—that is, if the right facets are being examined, the left side is raised. Sand bags steady the patient in position. The exposure will be about two and one-half times that given for an anteroposterior projection.

The superior and inferior articular processes should be well shown and the zygapophyseal joints definitely outlined. Pointed or irregular ends of articular processes indicate pathology. The "pars interarticularis"—that part of the posterior arch where the lamina and inferior articular process join the base of the pedicle and transverse process—is a vulnerable region and can be visualized adequately only in the oblique position.

Separations in the neural arch of the last lumbar vertebra, as in spondylolisthesis, are best shown in the oblique view, which also helps greatly in deciding whether such separation is possibly due to trauma. Subluxations of the zygapophyseal joints and the

degree of subluxation are best seen in this projection. It is often possible in this position to get a view straight through at least the upper part of a sacro-iliac joint.—*Edward N. Reed, M.D., Santa Monica, California.*

Las parálisis del nervio cubital en las fracturas del codo (Paralysis of the Ulnar Nerve in Fractures at the Elbow). Vincente Sanchis Olmos. *Revista de Cirugía de Barcelona*, XII, 82, 1936.

In the histories of 600 cases of fracture at the elbow, forty-two (7 per cent.) were found in which the ulnar nerve was affected, either alone or with other nerves. There were twenty supracondylar and six epitrochlear fractures, eight fractures of the external condyle, one fracture of the olecranon, and seven fractures of other types. Six patients had paraesthesia but no loss of sensation or paralysis. Twenty-two had paralysis in part of the ulnar distribution, and fourteen had complete paralysis.

Treatment consists of prompt reduction of the deformity and skeletal traction where it is possible. Surgical intervention is necessary where serious nerve injury is suspected or where nerve involvement is present after the fracture has been corrected. Six patients had operations. One had contusion of the nerve and subperineural hemorrhage. In two patients a pseudoneuroma developed from chronic contusion in abnormal position. One patient had no change at the level of the fracture, but the nerve was compressed in fascial scar at a lower level. Two patients were cured and four were improved.—*Edward Francis Keefe, M.D., Brooklyn, New York.*

The Non-Operative Treatment of Fractures and Dislocations of the Spine. Edward Thomas Newell. *Southern Medical Journal*, XXX, 799, Aug. 1937.

Spinal fractures are often overlooked in the first week after an injury. They should always be suspected and looked for. Fractures of the cervical spine are treated by head traction and hyperextension by means of a head halter and weight and pulley. This treatment is followed by the application of a plaster cast. Fractures lower down the spine are treated on a hyperextension frame with or without traction, followed by a plaster jacket for three to six months, then a back brace for six months or longer.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

The Surgical Treatment of Low Back Pain and Sciatica. Ralph K. Ghormley and Harrison R. Wesson. *Southern Medical Journal*, XXX, 806, Aug. 1937.

The authors have reviewed all the cases of low-back pain treated by bone-fusion operations at The Mayo Clinic. They conclude that a fairly high percentage of cures can be obtained by fusion of the lumbosacral and sacro-iliac joints. More accurate diagnostic methods are proving of greater help in selecting cases for operation.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

A Review of Cases of Congenital Dislocation of the Hip Treated at the North Carolina Orthopedic Hospital. W. M. Roberts. *Southern Medical Journal*, XXX, 987, Oct. 1937.

This is a review of forty cases, and the author advocates the application of preliminary traction before doing an open operation. This he thinks has facilitated the operation, reduced the time, and lessened the danger of trauma to the head of the femur. The choice of cases for open or closed reduction is not made according to age, but according to clinical and roentgenographic findings. In the majority of cases of open reduction, some sort of shelving operation is also done.

There were eight recurrences after reduction—two after open operation, and six after closed reduction. Sixty-four per cent. of the cases showed some changes in the femoral head after open reduction, and 60 per cent. showed similar changes after closed reduction. In the cases in which closed reduction was done better end results were obtained than in the cases in which open reduction was done. This may be due in part to the higher age incidence in the latter cases.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

A Case of Alternating Scoliosis with Proven Etiology. Robert A. Milliken. *Southern Medical Journal*, XXX, 1099, Nov. 1937.

The author reports the case of a woman, twenty-four years of age, who complained of pain in the right hip and leg of seven months' duration. She gave a history of a fall one month previous to the onset of symptoms. Various types of treatment had been tried without relief. Examination revealed a slender woman with extreme left sciatic scoliosis on standing. Marked flattening of the lumbar curve and forward leaning of the body from the hips were noted. She could bend forward freely, but attempts to stand erect caused a great increase in pain in the right leg down the sciatic nerve to the knee. When supine, the patient involuntarily shifted to a right scoliosis. At operation the spine of the first sacral segment was found to be abnormally long and hook-shaped, extending upward to meet a correspondingly long spinous process of the fifth lumbar segment which had a cartilaginous elongation. The two processes were not joined, but were in contact even in the flexed operative position. Extension of the spine made the processes slip by one another, and a slight twist of the pelvis could make them overlap on one side or the other. This caused an alternating scoliosis. Spinal fusion of the fourth and fifth lumbar vertebrae and the sacrum was done. One year later the patient's back was normal.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

Early Weight Bearing in Fracture Dislocation of Ankle Joint. Aaron H. Trynin. *Surgery, Gynecology and Obstetrics*, LXV, 379, Sept. 1937.

The writer sets forth three objectives in the treatment of these fracture-dislocations: (1) reduction; (2) maintenance; (3) functional return, the time and degree of which depend upon the former two plus early weight-bearing. Reduction and maintenance are accomplished by methods described by Böhler. Weight-bearing with a cane is started within a few days after the application of the non-padded cast and walking iron. The use of crutches is not permitted. Recurrence of displacement is not encountered. A period of from eight to ten weeks of walking in plaster is followed by from two to three weeks of physiotherapy. Apparently the same procedure without true early weight-bearing adds two to three months to the treatment period.—*Richard McGovney, M.D., Santa Barbara, California.*

Fractures in Children. J. Dewey Bisgard and Lee Martenson. *Surgery, Gynecology and Obstetrics*, LXV, 464, Oct. 1937.

The writers present some clinical and experimental studies with conclusions concerning the influence of trauma, particularly fractures, on the epiphyseal cartilage. Two hundred and thirty-two fractures of long bones in children were reviewed. In forty-nine the epiphyseal cartilage was involved. Only twenty-eight cases were followed over a year. Eight of these patients had deformities due to growth disturbance. The authors estimate that in 10 per cent. of fractures in children the epiphyseal cartilage is involved. Most growth disturbances are insignificant. Of the 232 fractures, 3.5 per cent. presented demonstrable deformities due to growth disturbance. Whenever infection was present, growth was arrested. Repeated manipulations increased the incidence of growth disturbance. It is preferable to be content with a reduction less than anatomical than to do multiple manipulations or open reductions. Four out of five of the cases in which open reduction was done showed changes. Internal fixation penetrating the cartilage is practically certain to produce growth arrest. Experimentation was done on nine young goats, and the growth changes were noted.—*Richard McGovney, M.D., Santa Barbara, California.*